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OPPORTUNITIES FOR TECHNICAL MEN IN MEXICO.

A recent report from our consul at Mexico City, Mexico, discusses the opportunities for employment in that country. This report discourages indiscriminate emigration, and takes the view that there is room only for men with capital and energy, and for those who have had a technical training. Mexico while in many senses a new country, is one which needs capital for its development. The type of pioneer who was so successful in opening the western states to civilization is likely to fail in Mexico because the country is already fairly well settled, and also because the climate is unsuitable. There are, it is true, large districts comparatively unsettled, but they are not promising for the small farmer. On the other hand, the man with plenty of capital will be able to make money if he goes about it in the proper way. He must, however, either have or be able to secure technical ability, for only in this way will he be able to get the wealth out of the natural resources which he commands with his capital. This opportunity exists not only for the engineer, but also for other professional men. Architects are needed, trained agriculturists and veterinarians—in fact, men skilled in any line of work.

Success May Come Slowly.

Our consul, however, warns such men that they must not expect to make an immediate success of their ventures. Indeed, it is probable that for some time they would not prosper as well in Mexico as if they had remained in the United States; but he believes that if they have the skill and the necessary courage to stay at it, ultimately they will do well. In addition to the technical training, the emigrant to Mexico should have a speaking knowledge of Spanish. Without a good working knowledge of this language, his chances for doing well are exceedingly small.

Opportunities Must Be Sought on the Ground.

The report states that it is useless to attempt to secure satisfactory positions by correspondence or through advertisements. It is the man on the ground who gets the appointment. But the would-be emigrant is warned that large sounding salaries are often very deceptive. These should always be reckoned on the gold basis, and it should be remembered that the cost of living in Mexico is just as great, if not greater, than it is in the United States. The energetic young man who has heard so much of the easy going methods of Mexico is apt to think that his temperament is sure to bring him success in that country; but this is a mistake, as he will not be able to stand the strain in that climate. Our consul believes that those who live in Mexico realize the pace which it is advisable to set, and that if this be exceeded, a physical breakdown is apt to follow. He questions whether, in nine cases out of ten, the same amount of energy and ability expended in this country would not accomplish much more than in Mexico. This warning, while it may be somewhat prejudiced, is timely, and it is to be hoped that it will have the effect of causing any young man who contemplates going to Mexico to examine carefully the conditions, and to look around his own country before he acts. Any movement of this kind, unless based upon most reliable information and guarantees, is risky. There will always be some unquiet spirits to whom the novelty of a new country appeals, but a few months of hard experience is usually sufficient to upset their plans. On the other hand, there are a few exceptional men who are suited for the positions they obtain, and who are sure to make a success. It is an instance where the old adage of "look before you leap" applies with particular force.

THE VALUE OF THE EXPOSITION TO ENGINEERS.

The St. Louis Exposition in its greatness, magnificence and diversity of attractions is a production—to use a theatrical term—in which the whole nation, as well as St. Louis, may take no little pride, and in our characteristic American way we have brought forth "the largest the world ever saw," which is also a source of satisfaction to us as a nation, however modest we may be individually. That it is the result of vast expenditures, which give no present promise of dividends, is of little moment—except to the shareholders—if an industrial and educational value is manifested which is measurably proportionate to the cost.

The question, then, naturally arises: of what value is the exposition to the engineer? Can it help him in his work, instruct him, lead him out of the ruts to newer and more improved methods, and be of lasting benefit to him, and through him to the country at large? And furthermore: does the exhibitor find a reward for his individual expenditures, in many cases amounting to very considerable sums?

It appears to us that the technical and industrial public, whether engineers, designers, makers or users of mechanical and electrical appliances, can find profit in some form from great expositions, provided they do not crowd too closely on the heels of preceding ones. There is little in the way of new principles, inventions, or processes that is unfolded. There is probably not a device or system in all the St. Louis technical exhibits that has not at some time or another been described in the scientific or industrial press, and the general principles of which are unknown.

It is, however, unfortunately true that as engineers progress the scope of their work becomes gradually narrower, and in this age of specialism there are probably few whose continued study, practice and observation cover a wide field.

A visit to the exposition reveals to the observing engineer many old principles reduced to new practice, and he sees the possibility of combining with his own special line, to its definite improvement, certain appliances which he has hitherto considered outside the range of his use. It also affords an opportunity for direct and extended comparison between various types and characters of design.

The newcomer in the manufacturing field, who has just begun to adventure in the exploitation of his products in competition with the well established companies, finds here an opportunity to show the advantages of his goods and bring them to the favorable attention of the engineer and prospective purchaser. And the foreign exhibits; they too, contribute no little toward our development and improvement. We here in America are more or less impressed by the belief that our genius for invention and ability to express it in concrete form as an operating mechanism, is superior to that of any other nation, and indeed of all the other nations combined.

With this national self-satisfaction we take no issue, but assuredly there is considerable genius extant outside of our native land, and while we undoubtedly may teach, we also can learn, and from the European exhibits we will gain very many helpful ideas, especially in the matter of details. The engineers abroad are not only skilled, but they are patient and careful, and in their designs the smallest and most insignificant details are given an amount of time and thought that we are scarcely able to put on them in this country. The smaller portions of American design usually reach perfection through evolution rather than from careful thought in the original design.

Altogether, the exposition will serve to broaden the view of the profession generally, and should result in no little benefit both to the engineers and to the manufacturers. It is true that the pessimist is abroad with his cry of *cui bono*, and the statement that there is nothing new or startling to be seen, but the facts remain, as we believe them to be, and we look confidently to many improvements in all technical work in the coming years, which have been inspired by the effect of the St. Louis exposition.

ELECTRIC HEATING.

While, on first thought, it would seem that electric heating stands little chance of success in competition with other methods, a little consideration will show that there are often opportunities for applying this method with advantage. There are, of course, those little applications, such as heating a chafing-dish or a curling-iron, where convenience counts for everything, and cost is not considered; but it is not these minor applications that we have in mind. In large factories having a central power plant, there are many opportunities for using electric heaters most advantageously. Sometimes a question of fire risk will override all others, and decide in favor of the electric heater as against gas. In such cases steam heating stands little chance as against electricity, because the former is more expensive to install, and, doubtless, in many cases costs more to operate, as steam can not be carried efficiently long distances by means of small pipes. It should be remembered here that when the electric heater is shut off, all loss ceases, but when your steam heater is out of service, the loss due to condensation is still going on. Here, again, the question of convenience may be considered, though it is not always important.

Electric Heating of Houses.

It would be rash to predict that electric heating of houses will soon be a well established system, but there are a good many points which can be urged in its favor. As against the furnace system or steam, it may be pointed out that each electric heater is entirely independent of all the others. There is no need to keep up a large fire in order to supply a small amount of heat to one or two rooms. This, of course, is assuming that there is some large central power plant from which a supply may be drawn. The same points can be made in favor of gas, but the latter system involves a number of disadvantages when compared with electricity. There is, first, the danger involved in the use of a flame. The products of combustion contaminate the air, and this must be provided

for by increased ventilation, which brings about a certain decrease in efficiency. Electric heaters need not be expensive, as they are simple devices; and, consequently, repairs should cost but little, and be easily made.

Ease of Application.

In certain applications the ease and surety with which a furnace heated electrically is controlled is a point of much importance, and is sufficient to warrant the greater expense involved by the use of this system. But the very fact that the furnace is always under perfect control conduces to efficiency, and this brings the cost of energy nearer to that of other systems. As to the actual cost, taking it all in all, there is not such a great disadvantage in the electric system and one can easily imagine a case where electricity and gas could be on a par in this regard. Such a case might arise where a water-power plant carrying principally a lighting load was idle during the greater part of the day. To what extent electric heating of buildings will be developed in the future no one can venture to guess; but after having done away with the smoky locomotive, will it not be time to turn our attention to the smoke and gases which pour out of every chimney during the winter? Electric heating would cost more, but the actual consumption of coal, on the whole, would probably not be increased. And will not the time come when we will be willing to pay the increased cost, in order to obtain the greater comfort? Is it not possible that what to-day would be considered a luxury—possibly extravagance—will before long become a recognized necessity? Stranger things have happened.

THE BOILER-ROOM PROBLEM.

How many managers of electric power stations realize that the problem of burning coal on a grate, in order to produce steam, is a purely chemical one, and that it requires considerable technical knowledge, as well as practical experience, if the best result is to be obtained? Coal is a complex material, consisting principally of carbon, but containing also hydrogen and oxygen, and some mineral material which constitutes the ash. When burned under ideal conditions, just sufficient air is admitted to the coal to oxidize completely the carbon and the hydrogen. An excess of air causes waste, since this unnecessary air carries off heat units to the chimney. The reverse of this condition also is wasteful, since it prevents complete combustion. The proper amount of air can be determined upon by a chemical analysis of the coal, or by an examination of the flue gases. The former, while giving an idea of the fuel value of the coal, does not assist the fireman in his work. The latter method is not difficult to apply in such a way as to give a constant check upon the operation of the furnace, and in this way to guide him in adjusting the supply of air. But how many boiler houses are fitted with combustion indicators, and how many are in charge of men who understand such devices and can be guided by them?

Sufficient Boiler Equipment.

Some may urge that it is more important to have the boilers managed in such a way that they will at all times meet the demands for steam, than to save a few pounds of coal. The boiler is one of the least expensive parts of the equipment of a generating station, and a sufficient number should be installed to enable the coal to be used to the best advantage. Expense is not spared in any other part of a station when it can be shown that the saving effected represents a satisfactory profit on the investment and there are few instances in which it would be advisable to slight the boiler equipment.

Mechanical Stokers.

The mere adoption of mechanical stokers does not, by any means, solve the problem of burning coal. In fact, unless the foreman of the boiler house understands boiler operation the result may be less satisfactory than hand-firing. The engineer who thinks that, by the use of mechanical stokers, he can replace his skilled firemen by one skilled mechanic and a number of helpers, is apt to find his coal bills disappointingly large. That the stoker conduces to regular operation will not be questioned, but it only does what it is set to do; and if the man in charge knows no more than that he is producing steam enough, he is apt to lay a heavy burden of expense on the station.

Chimneys and Smoke.

The building of a large chimney should always be well considered to-day. The object of the chimney is to cause a draught, and some engineers seem to forget that they every day pay for this draught in coal burned. Are we not apt to overlook this fact, and to consider the chimney as a good investment if the interest on its cost is considerably less than the expense of operating a system of mechanical draught? Do we not often fail to realize that about twenty per cent of our heat units are going up the chimney, and that as a means of moving air the chimney is not efficient?

The smoke question is another which is bothersome at times, and often stations are put to considerable expense either for costly apparatus or for high-grade coal, when there should be no such necessity. Any coal can be burned perfectly in a suitable furnace and this should be realized before the plant is built. Is it not foolish to build a furnace to make smoke, and then add devices to get rid of it, or to resort to other means, such as burning costly fuels? Illuminating gas, under normal conditions, does not produce smoke; but place a cold piece of metal in the flame and it is blackened immediately. If the flames in the furnace, coming in contact with the cold metal of the boiler, are cooled down below the temperature of combustion before complete combustion has taken place, smoke is sure to result; and while smoke itself is not objectionable, it may not be, from the station manager's standpoint, the most objectionable feature of this condition. Smoke is an indication of incomplete combustion, and incomplete combustion means wasted fuel. The proper course to follow is, first, to have the furnace built correctly; next, to study your coal—have it examined, learn what it should do and then find out what it is doing for you; watch the chimney for smoke, and watch the flue gases. Our methods of producing power from coal are, unfortunately, inefficient, but this is only the more reason why no possibility of improvement should be neglected.

TELEPHONE ENGINEERING—IX.

BY J. C. KELSEY.

THE TWO-STRAND, DOUBLE-BATTERY RETARDATION SYSTEM.

Every telephone system so far discussed has made use of a repeating coil in the cord circuit. The windings of the coil individualize the cord circuit, prevent cross-talk, repeat the fluctuations of the voice currents and give the means for a natural busy test. If the coils are properly designed, they will preserve the balance of the connection under both grounded and metallic conditions. The earliest workers along these lines naturally clung to the repeating coil. Along with the repeating coil clung the non-inductive relay. Both seemed indispensable. The development of the two-strand system, so far, shows the repeating coil and non-inductive relay in Fig. 14. It also shows a ground at the subscriber's station.

A ground at the subscriber's station is not a good feature, for several reasons. It causes extra expense in office and house wiring, it brings into action the ever poor and unreliable ground connection, and a conflict with earth currents of various potentials. It causes the switchboard to be dependent upon the line circuit for the operation of its most necessary function. By this is meant the idea that a switchboard should be self-contained; that the supervisory lamps should light regardless of outside conditions.

If the ground at the subscriber's instrument be removed and placed at the central office, the most likely place would be one terminal of the cut-off relay, which is connected in the drawing at *c* at the tip spring. To plug into a jack, with a ground at the old tip side of the cut-off relay, would cause current to flow in unequal amounts through the relay AR and cause the lamp to light. The entire current would pass through winding A of AR. When the telephone is removed from the hook, the current will then flow out over the line and back through winding B of AR, but not in equal amounts, because some of the current through winding A has passed through the cut-off relay winding back to the battery without passing through winding B. If, however, cut-off relay COR had infinite resistance, or an amount of great proportions, the differential relay could be used. But in practice it would be impossible to cause the differential relay to operate successfully with the cut-off relay grounded at the point *c*.

In view of these difficulties, Mr. Dunbar, of the Kellogg company, dispensed with repeating coil and non-inductive relay entirely. He grounded the cut-off relay at *c* in Fig. 15, and made use of two relays in the respective halves of the cord circuit. These relays served as retardation coils, and they served the purpose of individualizing the cord circuit and preventing cross-talk. The use of condensers served to repeat the fluctuations of the voice currents, while the coils on the tip side of either calling or answering cord will give the means of natural busy test, just as the quarters of the repeating coil do. With Mr. Dean's addition in the shape of an original subscriber's instrument, the system to be described may be said to be the typical retardation system.

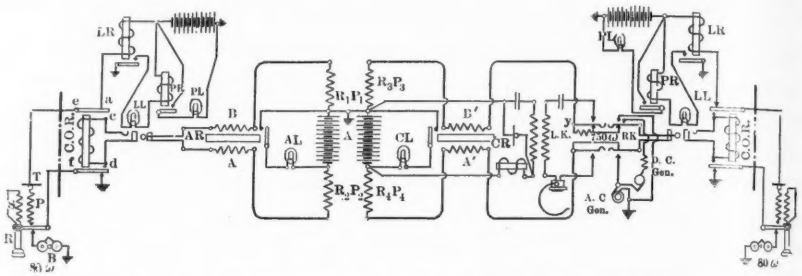


FIG. 14.—SHOWING REPEATING COIL AND NON-INDUCTIVE RELAY.

The subscriber's instrument is shown in Fig. 15, in which T is the transmitter, R the receiver, K the condenser, B the ringers and RET the retardation coil of twenty-five ohms' resistance. With the receiver on the hook, the condenser forbids the flow of direct current through the line relay, which otherwise would cause a permanent line signal. An alternating current would pass over the line over line side 1, through ringers B, through lower point of hook *q*, lower point *r*, thence through condenser K, back to generator over line side 2. When the receiver is removed from the hook, the switch closes the points *t* and *s* and opens *q* and *r*, cutting the bell out of the talking circuit, removing the short-circuit from the receiver, placed there to prevent the flow of alternating current through it, and closing the battery circuit through the transmitter T and the retardation RET.

This arrangement prevents the flow of battery current through the receiver during conversation and the flow of alternating ringing current in case the receiver is removed while the operator is ringing on the line. It prevents a click in the receiver when the subscriber raises and lowers the hook with the receiver to his ear. It enables the usage of a low-resistance ringer as well. In speaking, the retardation effect of RET is neutralized by the paralleled condenser and receiver. Like the Bell common-battery instruments, the condenser is a necessary adjunct of the talking effect as well as the ringing.

Calling central is accomplished when the removal of the receiver places the transmitter T in series with retardation RET across the line. The current then flows from battery A over line side 1, through the contact of the cut-off relay *a*, through line relay LR, through the subscriber's transmitter and retardation coil, back over line side 2, through the contact *b* of the cut-off relay to ground. This causes line relay LR to become actuated, lighting the line lamp LL and actuating the pilot relay PR. The actuation of pilot relay PR closes the circuit of the pilot lamp, which receives its current through the windings of the night

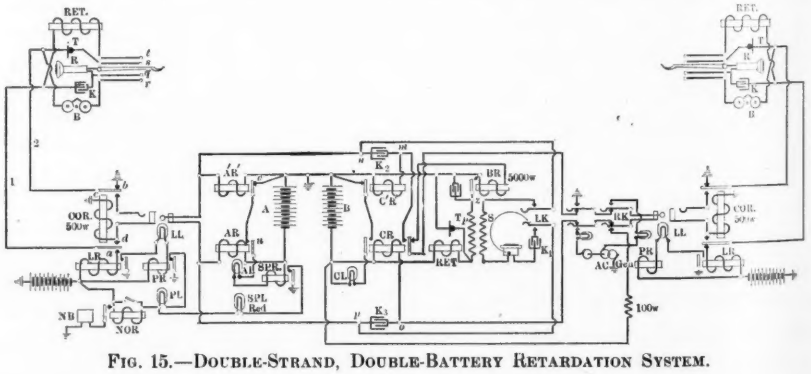


FIG. 15.—DOUBLE-STRAND, DOUBLE-BATTERY RETARDATION SYSTEM.

bell relay. As the night bell relay has a low resistance of one ohm, it does not interfere with the brilliancy of the lighted pilot lamp; nor will the one-ohm pilot relay interfere with the line lamp. The night bell relay closes the contacts of a night bell which would ring, were it not that during the day a switch short-circuits its windings and renders it unresponsive to the currents passing through to the pilot lamps.

The act of plugging in to answer the call causes the line lamp LL and the pilot lamp PL to be extinguished, because the entrance of the plug has caused the cut-off relay to become actuated. With the circuit broken at point *a*, the line relay becomes deenergized and opens the battery circuit of the line lamp and pilot relay in series. This, in turn, deenergizes PR, and lamp PL is also extinguished.

The cut-off relay is actuated when the sleeve of the plug touches the sleeve of the jack. This causes current to flow from battery A, through relay AR, thence to sleeve of plug, sleeve of jack, point *d*, relay COR, to ground at point *c*. Not only is COR actuated, but relay AR as well. The actuation of relay AR closes the circuit from battery A, supervisory pilot relay SPR, lamp AL, makes contact *u* and breaks contact *v*, causing lamp AL to light and the supervisory pilot lamp SPL as well. But as soon as the tip of the plug comes into contact with the tip of the jack, the relay A′R′ will be actuated as the circuit of the subscriber's instrument is closed, which allows battery to flow over the tip side of the line through A′R′. The actuation of A′R′ breaks the supervisory lamp circuit at point *v*, extinguishing the lamp AL and the supervisory pilot lamp SPL also. Should the subscriber raise and lower his hook, the relay A′R′ would be alternated and the lamp AL alternately flashed and extinguished.

The supervisory pilot lamp is an original feature and is one of the most important developments in common battery service. In series with the cord supervisory lamp is the one-ohm relay SPR. Every answering cord lamp derives its battery through the winding of this relay. When the operator is very busy, even the supervisory lamp fails in its duty. And the supervisory lamp is one of the boasted advantages of common battery practice. Most companies safeguard the calling of central by the use of a line pilot lamp, seemingly with the idea that the calling of central promptly is the most important point of operation. This is hardly true, as a great number of telephone calls are made with the intention of calling more than one party. Therefore, it is just as necessary to be able to signal the operator for a second call as the first. The supervisory lamp is rather inconspicuous and is not as plainly seen as it should be. If the pilot lamp flashed in unison with the answering pilot lamp, it stands to reason that the operator will act more quickly. It saves the service of monitors to a certain extent. And a system without the pilot lamp in connection with the answering supervisory lamps is certainly in possession of a weak spot.

To answer the call, the operator throws the listening key LK, which places the secondary winding and receiver across the cord circuit at the points *n* and *p*. The condenser K_1 is placed in the secondary circuit to prevent the receiver click and confusion of signals. In Fig. 14 the means of connection between the two cords is the repeating coil. In this system, the two condensers answer the same purpose. Condenser K_2 connects tips at *m* and *n*, while K_3 connects the sleeves at *o* and *p*. The voice currents can not pass through the windings of the relays, as they are there for the purpose of preventing voice currents from other sources from entering. They simply individualize the cord circuit, while the condensers serve to repeat the fluctuations of the voice currents. With the condensers missing, the answering and calling parties would be as isolated as if connected to entirely different cord circuits.

Ascertaining the desired number, the operator tests in the usual manner. If she receives no clicks she knows the line is not busy and inserts the calling plug. The act of inserting the plug energizes the cut-off relay COR, which relay has two functions. It disassociates the line signal apparatus from the line during a connection and associates the multiple jacks, which are normally disconnected. It also energizes the relay CR, which controls the lighting of the calling supervisory lamp CL. Current flows from battery B, through CR and COR, to ground. This causes CL to light. Calling the party is done by throwing the ringing key RK. As this is a two-strand system and the energy for the cut-off relay is furnished over the strands of the talking circuit, the operation of the key will open the circuit through CR and COR, and COR will disconnect the multiple jack terminals. This would render the ringing futile, unless during the act of ringing the relay COR is temporarily energized. This is done by placing the generator on the tip side of the ringing spring and connecting the sleeve spring to battery through 100 ohms' resistance, as the cut-off relay is normally supported by the 100-ohm resistance relay CR. The ringing current then passes over the line, through the ringers and condenser, thence back to the office ground through the battery. As the battery has an exceedingly low resistance, a ground through its medium is just as efficient as a direct ground.

When the called party answers by removing the receiver from the hook, the current flows through relay C′R′ and opens the lamp circuit of CL through its back contact. When both parties are talking, the answering supervisory lamp, supervisory pilot lamp and calling lamp are darkened. When the called party hangs up, CL will light. If the calling party wants a second party, a single motion of the receiver hook will flash AL and SPL and attract the operator's attention readily. Three lamps lighting permanently, the operator pulls down the connection.

If the line is busy the operator gets a succession of clicks in her receiver. If she would touch the answering plug to a busy jack, she would get a fair test, for the relay A′R′ has the same faculty of storing up energy as the quarter of a repeating coil. Withdrawing the tip from the busy sleeve would allow the stored up energy in A′R′ to expend itself in the bridged receiver. This would be very well with a three-strand system. But in a two-strand system, one talking terminal is used as a testing terminal. The touching of the tip to the busy sleeve would put a 100-ohm path to ground on the sleeve, which would so materially reduce the potential of the test terminal, or weaken the battery strength of the line, as to give the talking subscribers very serious disturbance and annoyance.

The system shown in Fig. 14 inserted a 700-ohm resistance in the tip circuit during a test to weaken the disturbing effect. The system in discussion uses a 5,000-ohm resistance. It is in the form of a relay which acts for the entire operator's position. This necessitates that when a cord is in use, the busy test apparatus shall be disconnected. This is done through the medium of the relay CR, which, in addition, has the function of closing the talking circuit and closing the lamp circuit of CL when the plug is inserted into the jack.

Touching the tip of the calling plug to the sleeve of a busy jack causes a flow of current from the sleeve terminal through the tip to point *i* of CR and

point *j* also, thence to ground through the busy relay BR. As the relay BR has a high resistance, the current flowing will be very slight, and this necessitates that the busy relay be wound with many turns, so that the slight current will readily operate it. By having considerable impedance, the current in the relay winding rises slowly, which causes the potential of the line terminal to be reduced so slowly that the talking subscribers are practically unaware that a test is being made. Relay BR operates each time the tip is touched to the busy sleeve, so the armature is arranged to put a ground on the primary circuit in such a way as to convey a click in the operator's receiver. At *z* the primary winding is connected to the armature of BR. When BR operates, the current flows from the battery through the 200-ohm impedance and the primary winding to the ground. This induces an impulse in the secondary circuit, which the waiting subscriber can hear as plainly as the operator.

The operator's common battery set is composed of the customary condenser, transmitter, impedance and primary winding, with the condenser, receiver and secondary winding. A little difference may be noted in the general arrangement. Ordinarily, the transmitter is placed directly in the battery circuit, with a condenser to offset the impedance, seemingly separating the transmitter and primary winding from the battery and impedance. In this case, the transmitter and condenser change places. One would think such a change would be of little effect. The change produced is great. In the first case, like the licensee circuit, the primary winding is coursed by a pulsating current. In the case at hand, with the condenser in the direct current, the primary winding is coursed by a pure alternating current. Tests made show no superiority of one over the other, which would prove the uselessness of the early labors to perfect a transmitter that produced an alternating current in the primary circuit.

There is no ring down key in this system. To accomplish a trunk connection, the simple act of pressing the order button OK will get the B operator's attention. At night the pressing of OK causes a current from the B exchange battery to pass through a relay, causing a lamp to light. It makes the A operator's set act as a common battery subscriber. It is quite an improvement over the combination of order key and ring down key to throw down a drop at the B office.

Costs and Profits of Electric Railways in Germany.

[*From United States Consul-General Mason, Berlin, Germany.*]

The enforced publication of corporate finances and the exhaustive methods by which municipal accounts are kept and made public in Germany have enabled the Association of Electrical Engineers to collect and formulate some highly interesting statistics on the financial results which have followed the change from horse to electrical traction in street railways in this country. Although this transformation began later here than in Belgium and the United States, it was made with such promptness and energy that within a period of four or five years the horse car practically disappeared from Germany and was replaced by electrical tramway systems, which traverse all the cities and larger towns and connect each of them with practically every village and hamlet in a large and constantly extending radius. These systems have now been in operation long enough to supply some definite data as to the profits of such enterprises under existing conditions in Germany, which, measured by average street railway dividends and the market values of their shares, have been in general somewhat disappointing. The net fact, which has been known to investors for some time, and which these newly formulated statistics confirm and explain, is that electric street car lines, while serving the public infinitely better than any other method of city and suburban transportation yet devised, have proved in many, if not most cases, less lucrative to shareholders than the horse car lines which they replaced. There are several tangible reasons for this, some of which are more or less peculiar to Germany. Among these may be cited the fact that most German municipalities refused at the outset to permit overhead conductors to be used in important or centrally located streets, and the companies were therefore forced to use a costly type of car which would take its current in the suburban streets from an overhead wire carrying a voltage sufficient to charge at the same time storage batteries of sufficient capacity to run the car through the central districts where the trolley wire was forbidden. These storage batteries were heavy and expensive, they deteriorated steadily and were difficult to keep in order, and when the snow and ice of winter encumbered the tracks they failed so utterly in Berlin, Hanover and other cities, that thousands of cars equipped with them had to be thrown out and their storage batteries removed. It was only at this heavy cost that the overhead trolley wire secured admission to the central districts of several German cities, and there are even yet in Berlin and elsewhere long stretches on important avenues where it is tabooed and underground conductors are insisted upon as indispensable.

A second important fact in this connection is that German municipalities are very exacting with tramway companies in respect to rates of fare, paving and all the other specifications of their franchises. Every step in the process of construction is subject to the inspection and control of the city engineers. Most franchises involve the responsibility of the company of laying and keeping in repair the pavement on all space between the two outer rails, a breadth, in case of double tracks, of twelve to fifteen feet or more, and where, as in Berlin, the pavement is asphalt laid on deep foundations of rubble and cement, this becomes a heavy item in the cost of construction and maintenance, for no skill and experience seem able to avert the necessity of frequent upheavals for purposes of repair, in which asphalt and cement have to be cut out with cold chisels driven by sledges, a slow and toilsome operation.

Moreover, there are very few municipalities in Germany where electric current can be generated by any other or cheaper power than that of steam or gas engines, and no form of steam fuel is really cheap in this country. Although a very few of the largest central stations produce electric power as low as one and one-quarter cents per kilowatt-hour, in most others the cost averages from two and one-quarter to three and three-quarters cents, and in certain small stations as high as ten cents per kilowatt-hour. Estimated by the ordinary German standard, the power consumption per car varies with grade, curves and other conditions from 450 to 700 watt-hours per car-kilometre, equal (in case of the latter figure) to 1,170 watt-hours per car-mile.

Finally, the outlay for track renewal and repair turns out here, as elsewhere, to be unexpectedly heavy. In the days of horse cars a well laid track in a city of from 150,000 to 200,000 inhabitants would last from a dozen to fifteen years. Now, with the far heavier and more frequent cars, the rails, especially at curves, wear in much less than half that period until the wheel flanges are found running on the bottom of the groove, so that the track has to be taken up and renewed. Another cause of frequent and expensive repairs lay in the fact that the surface

resistance of the copper bonds with which the rail ends were united increased rapidly under certain conditions, until their use was largely superseded by the better system of welding the rail joints by means of electrical heat or thermit.

Still another increased item of expense has been that of labor. The motormen are naturally employés of a higher grade than horse car drivers, and being well organized, they have been able to compel increased wages and to shorten working hours until the net labor cost per car-kilometre is more than fifty per cent greater than in former years.

To all this is to be added the fact that the rates of fare in most, if not in all, German cities are rigidly restricted by the authority granting the concession. In Berlin, for instance, street railway fares anywhere within city limits are restricted to ten pfennings (2.38 cents), and for the same sum the passenger may ride on some of the suburban lines any distance up to seven kilometres (4.34 miles). From the latest published statistics it appears that the average street railway fares paid in eleven principal German cities during the year 1903 varied from 2.2 cents each at Frankfort to 2.72 cents at Hamburg, the mean average for Berlin and its suburbs being 2.35 cents, or less than half the usual five-cent fare that prevails generally in the United States. To complete the restrictions under which street railways operate in this country, most of their charters contain clauses providing that from a prescribed date the company shall pay to the municipality a portion of its surplus after disbursing a stipulated percentage as dividends. A typical contract of this kind stipulates that beginning with 1903 the company shall pay to the city thirty-five per cent of its surplus remaining after a six and one-half per cent dividend has been paid to stockholders, and fifty per cent of the surplus after an eight per cent dividend. Many charters further provide that after being operated by the companies for a specified term of years the whole installation, tracks, power plant and equipment shall revert in fee simple to the municipality which has granted to the corporation for a term of years the use of its streets.

The total length of German street railways at the close of 1902 was 1,906 miles, of which 346 miles, or about eighteen per cent, were under municipal ownership. Of the latter, sixty-five miles were leased to individuals, leaving 281 miles of lines operated directly by the municipalities. The four longest municipal lines are at Frankfort, twenty-six and one-half miles; Düsseldorf, twenty-five miles; Munich, twenty-nine miles, and Cologne, forty miles. It does not appear that fares over these lines are lower, but, on the contrary, that they are rather higher than those charged on similar lines worked by individuals or corporations. In Nuremberg, for example, the principal street railway charged, under private management, a uniform ten-pfennig (2.38-cent) rate, until the city, in order to complete a zone system, took over the private line and thereupon increased the rate of fare. On the whole, it can not be said that experience has increased public sentiment in Germany in favor of municipal management of street railways, and several cities—among which is Barmen—which built their own lines are now considering the plan of leasing them to private companies.

By far the largest and most important corporation of this kind in Germany is the Great Berlin Street Railway Company, which, with its various branches, operates 200 miles of track, of which 144 miles are owned and the remainder are controlled by the company. On its own lines the "Groose Berliner" ran last year 40,400,000 car-miles and carried 295,000,000 passengers, whose fares aggregated $7,025,000. The total capital of the company is 100,082,400 marks ($23,819,611); its shares are to-day worth 184, and its three and one-half per cent bonds are quoted at 99.40. This, however, is the status of an exceptionally powerful and ably managed company in a large, level city, and is quite above the average financial condition of street railway companies elsewhere in Germany, most of which have to be satisfied with four and five per cent net earnings on their stock.

The Berlin company is at present in litigation with the city over a question which, as it involves the important point whether a municipality may grant franchises to new companies on streets already occupied by another lessee, has a certain pertinent interest in this connection. About two years ago there was opened for traffic the so-called elevated and underground railway, a double-track electric line of the most perfect construction and appointment, with two arms or branches running from a central station to points in the eastern and western parts of the city. Trains of three cars run over these branches at intervals of three to five minutes and at such speed as to traverse a distance of two and one-half miles in about ten minutes. The line is very popular and carries an immense and steadily growing traffic, which naturally trenches more or less upon the business of the surface lines which belong to the "Grosse Berliner." In order to reach a still more central and crowded portion of the city the new company asks authority to extend its subterranean main stem from the present terminus at the Potsdamer railway station northeastward to a point beyond the river. To this the great Berlin company objects, and the municipality has applied to the courts to confirm its authority to disregard the protest and grant the franchise for what would be an important public improvement.

The one all-controlling fact which has enabled street railways in Berlin and other German cities to make head against the exacting requirements of municipalities and the enormous cost of conversion from horse to electric traction, with the increased outlay for labor, workmen's insurance, paving and other expenditures, has been the phenomenal increase in business, particularly in the suburban traffic in all the larger towns, which has come with the increased speed, the greater frequency of service, the better ventilation, space and comfort of electric cars. Whole suburbs have been built up within a few years by the influence of a single well-managed tramway line, which carries a legion of men and women to and from their daily toil in the city more quickly and cheaply than the horse car could transport them half the same distance. And although the electric street railways of Germany under the conditions above described are but moderately remunerative to shareholders, they hold a high place among the potent influences of modern civilization.

Steps toward the Protection of Workmen on High-Tension Conductors.

The Association des Industriels de France Contre les Accidents du Travail will hold an international congress in Paris in June, 1905, for the purpose of investigating apparatus for ensuring the greater safety of workmen employed on high-tension conductors. The device will be expected to indicate safely and plainly whether a conductor is alive or not. It must be applicable to direct and alternating currents of all voltages and incapable of doing damage to itself, the conductor or distribution system. A prize of 6,000 francs will be awarded to the exhibitor whose apparatus best satisfies the qualifications, the system remaining the property of the inventor.

Adaptation of Alternating Currents to Railways.[1]

A peculiarity in the development of electrical railroading up to the present time is the fact that the type of motor employed has remained practically unchanged. Sprague, in Richmond, in 1887, used a direct-current series motor, which type, with few exceptions, is used to-day. Tests of other types of motors have all seemed to prove the superiority of the series motor for traction purposes. There are two features which make the direct-current series motor preeminently up to date in the railroad field: one, that the motor is inherently a variable speed one—it will adjust its speed automatically to the load conditions which it is called upon to meet; the other, that its torque varies nearly in proportion to the square of the current input. In other types of motor the torque varies at a slower rate than the square of the current input. This property evidently reduces the amount of current required for a given tractive effort, other things being equal, over that required by another type. The entire traction problem may be divided into three elements: first, the generation of power; second, the transmission of power from the generating station to the cars or trains, and third, the application of power to the cars or trains. The application of power has demanded a motor characteristic as good as that of the present direct-current series motor. Nothing better for traction purposes than direct-current series motor having been offered, the other elements of the system have been subservient to the motor requirements. With the development of electric traction, the handicap introduced by the necessity of using the direct-current series motor for the operation of trains or cars has been more and more apparent.

To gain an idea of the traction problem existing to-day a glance at the course of development of electric traction will be of value. The original Richmond plant consisted of a power station which generated current at approximately 500 volts, a transmission system of sufficient capacity to take the current from the power station to the cars without an undue amount of loss and direct-current series motors upon the cars. For a number of years this was the universal method of procedure, but with increased distance and amount of power required, the weight of copper necessary to carry current from the generating stations to the cars, with this system, became prohibitive. Two remedies were available: to put in more power stations, or to generate a higher voltage at the power-houses. The disadvantage of the former was recognized as being the greater, therefore the necessity for the higher voltage brought into use the "booster" system. By means of these boosters, the voltage generated at the power station and transmitted to the more distant parts of the system was made to vary automatically with the current transmitted. This variation was adjusted to the losses which occurred in transmission to these more distant parts so that the voltage supplied to the cars would not exceed the normal. The system was not economical in its use of power and further extensions of electric traction demanded something better.

At this point it was recognized that the transmission element was the one which was deficient. It again became a question between the multiplication of the number of power generating joints and the increase of transmission voltage. The electrical engineer again cast about him for some way of avoiding the necessity for increasing the number of generating stations. It would have been desirable, to gain the voltage necessary, to use alternating currents, but the demands of motor equipment made the retention of the direct-current series motor necessary, no alternating-current motor having been developed of such characteristics as to justify abandoning the direct-current motor. The result of these conditions was the rotary converter substation system. This system was designed to meet the two requisites of electrical traction as it had existed up to that time—high-tension transmission voltage—high tension as compared to the voltage usually used in electric traction—and the use of direct-current series motors, since that type was the only one extant, which possessed suitable characteristics for traction purposes. The proper voltage for a given case depends upon the condition, and the range to select from is a wide one—between 2,000 and 50,000. Transmission voltages in common use on traction lines are 10,000, 15,000 and 20,000. Voltages of this magnitude are out of the question with direct current, since any higher voltage direct-current generating arrangement is both expensive and deficient from an engineering standpoint.

The requirements of an alternating current from the transmission line and direct current on the motors made necessary a connecting link in the rotary converter, which, with its complement of "step-down" transformers, is capable of taking energy from the high-tension alternating-current transmission lines and delivering it to the trolley in the shape of direct current at a voltage of from 500 to 700. The most apparent disadvantages of this system consist in: first, the necessity of using the rotary converter. It is an expensive piece of machinery, absorbing about ten per cent of the power passing through it under the conditions of usual interurban operation; its maintenance is expensive; it is difficult to start; the load which it will carry is limited to a maximum set by the conditions of commutation as well as to an average set by limits of temperature; it is a piece of moving machinery and consequently requires constant skilled attendance. Second, the necessity of distributing power from the rotary substations to the trains at a voltage low enough to allow of direct application to the motors. Direct-current series motors, though eminently suited to traction work, have certain disadvantages; one of the worst is the tendency to flash under certain conditions; that is, the tendency to arc over from brush to brush on the commutator. Another disadvantage—but not peculiar to the direct-current motor—lies in the difficulty of maintaining the motor insulation. Increased voltage exaggerates both of these disadvantages. The maximum voltage which can safely be taken care of under the severe conditions of street railway practice is possibly as high as 700, although 650 is usually the limit and 550 is in much more common use. In considering distribution problems, this maximum of 650 to 700 volts works a decided hardship. To distribute power from substations to cars requires an investment for distributing conductors and entails a loss of power. To decrease the first cost of conductors or the loss of power or both, the voltage of the distributing circuit must be increased or the distance of distribution lessened.

It has long been recognized that a motor which could operate on an alternating current and which would possess at the same time speed and torque characteristics of the direct-current series motor, would avoid the disadvantages which are most pronounced in the present direct-current system. Mr. Lamme has experimented since 1893 in a successful attempt to perfect an alternating-current motor with these characteristics. The basis of his work on the alternating-cur-

[1] Extracts from a paper presented by Mr. P. M. Lincoln before the Engineers' Society of Western Pennsylvania.

rent motor is the fact that an ordinary direct-current series motor will operate in the same direction no matter what be the direction of current through it as a whole. Reversal in the direction of rotation of the direct-current series motor is got by reversing the direction of current travel through the field relative to the armature. From the fact that it makes no difference which way the current travels through the motor, it follows that if the current be reversed very frequently the direction of rotation and the speed torque characteristics will not be interfered with. It follows, therefore, that the commercial direct-current series motor is of a type which will operate successfully on alternating currents, provided the frequency of alternation be low enough. The introduction of alternating currents of commercial frequency with this type of motor brings up many problems on whose solution the success of such a motor depends. The difficulties are: (1) the commutation; (2) the losses due to circulation of alternating current; (3) high self-induction.

The substitution of the alternating-current motor for the direct current will make practically no change in the elements of generation and application, except in the changing of the direct-current motors for alternating current. The transmission element may be divided into two parts: first, high-tension transmission from generators to substations, and second, distribution from substations to cars. For the first, the change will be simple—that from polyphase to single-phase transmission. The second part will be modified by the abolition of the rotary converter and the adoption in general of higher alternating-current distributing voltage in place of the 500 to 600 volts, direct current, of the present day. The substations will be more frequent, but will be reduced to the static transformer.

The current will be taken from the high-tension line and reduced to a potential which can be safely put upon the trolley. The saving in cost of skilled attendance will reduce operating expenses so that the substations may be more frequent and the distance which the current will have to go from the substations to the trains will be much shorter. This will reduce the cost of the conducting system between the substation and the cars and will also reduce the losses. Among the advantages derived from the use of alternating-current, single-phase motors compared to the present direct-current motors necessitating rotary converters, are the following:

First—The abolition of the voltage limit for distributing circuit (the cost of the distributing circuit of the present direct-current system between substations and cars amounts to forty or fifty per cent of the total output for apparatus); by raising the voltage the cost of the distributing system may be reduced to a comparatively small fraction of that necessary in a direct-current system.

Second—Rotary converters done away with.

Third—Avoidance of skilled attendance in substations.

Fourth—Avoidance of rheostatic losses at the cars, due to the fact that alternating currents can be controlled by inexpensive apparatus—a property not possessed by direct-current voltages.

Fifth—Electrolysis abolished.

Sixth—The ability to use low-voltage motors on a high-voltage trolley; the change of voltage between trolley and motors may be accomplished by a transformer carried by the car. The transformer is better prepared to take care of high-voltage strains than the motor.

Among the disadvantages against the alternating system are:

First—Increased weight of equipment, due to the regulating devices and the transformer on every car.

Second—The increased loss in iron conductors of alternating current over direct current.

The Westinghouse Electric and Manufacturing Company, of East Pittsburg, has operated single motors and complete equipment and has already taken four contracts for railroads to be equipped with alternating-current apparatus.

The discussion of the paper brought out the following points: the standard frequency of these motors will be twenty-five cycles per second, which is the standard already adopted for many powerhouses. In the matter of voltages, any one desired can be adopted.

The control of the motor is a voltage control. One of the means of changing the voltage of the motors and keeping a constant trolley voltage is to bring out loops from the transformer windings so as to obtain a number of different voltage points, and to throw the motors from point to point on the transformer winding as it is desired to change the voltage. This method has some objections; the one which will probably be very largely used consists of a transformer whose secondary is movable with reference to its primary, so that by moving the secondary through an arc of eighty degrees a variation of the voltage required in the motors may be got. This turning is done by means of an air motor.

In the collection of current in the operation of large trains the use of the alternating current will greatly reduce the difficulty. In the alternating-current motor the starting torque is probably a little greater than in the direct current.

Completion of the Alaskan Cable.

When the United States cableship Burnside steamed into Seattle harbor a few days ago with the home end of the wire rope that extends a thousand miles northward and connects almost every town of any size in Alaska with the United States and all the world, a triumph had been achieved in more ways than one. The cable just completed extends up the coast to Skagway, at the head of Lynn canal. Connected by branches are Sitka, the nominal capital of Alaska; Juneau, the real capital, Haines Mission and two or three other places. From Skagway a Canadian line extends across White Pass and down the Yukon to Dawson. From Dawson there is a line back across central Alaska to the coast, terminating at Valdez. This from the Canadian boundary is owned by the American government. Branching off from this line another wire leads down the Tanana river, a tributary of the lower Yukon, on down the Yukon to its mouth, ending at St. Michael. Within a few months it is hoped to have St. Michael and Nome connected by wireless communication across Norton sound, 115 miles, and the Alaska system will become all-American by the laying of a cable along the coast from Skagway to Valdez. The Burnside will lay this cable without delay.

Long before this it was hoped to have the Seattle-Skagway cable in operation, but vexatious delays in receiving the material from the manufacturers last fall prevented, and the signal service officers of the army in charge of the work were compelled to suspend operations through the winter because of the rough weather, while the Burnside went to the Philippines to repair cable laid a year or two before among the islands of the archipelago. Work was begun at the northern end and as the vessel progressed southward everything was in working order and communication was kept up on the vessel with the Alaska ports as the reeling machinery spun the wire over the stern.

All through the winter an end of the cable lay buoyed 130 miles south of Sitka. This much of the work had been completed, and since last fall Juneau and Sitka have been talking to each other under the water and to the "outside" over a wire 2,500 miles long by way of Dawson and Canadian territory to Vancouver, B. C. But this was not as convenient or as inexpensive as now, though it was a big thing for Alaska people to know what was going on in the world as gathered from meagre despatches that found their

way through a wire almost as long as the continent is wide.

Before the Spanish-American war the United States had no cable and their signal corps officers had not had experience in handling it. The service had not a single grappling machine, much less a cableship, or even a man who had ever laid a foot of cable. But the necessity for cable arose with the acquisition of the Philippines, and when the Spanish merchant ship Rita was captured by the converted cruiser Yale off the coast of Cuba it was remodeled for a cableship. About Manila 2,000 miles of cable were laid and when this year's work is over the Burnside, as the Rita was rechristened, will have laid 1,500 miles more.

Most of the distance along the coast the wire lays in 1,000 fathoms of water, but in rounding Vancouver Island, just before entering the straits of Juan de Fuca, a depth of 1,600 fathoms, 10,000 feet, was encountered. From the Sitka end to the entrance of the straits required 500 miles of cable, weighing 1,500 tons —a good sized load for the ship. Midway in the straits the end was buoyed and the Burnside came back for more and then steamed into Seattle harbor ready to connect with the line running from the shore to the Walker Building, in Seattle, where the signal corps officers are located and where with the most delicate electrical apparatus the officers for months have been practising sending and receiving messages and studying up on cable lore.

General A. W. Greely, chief of the signal corps and ranking brigadier-general in the army, who has had charge of all the work in Alaska and has directed operations personally, both in laying the cables and stretching wires, has encountered obstacles that seemed insurmountable in opening up this big system of communication in Alaska, and has met discouragements that to a man less bold or persevering would have meant failure. Stringing wires on poles across thousands of miles of uninhabited country, where winter occupies a good share of the year and where summer merely adds to the difficulties, is not like such work in more favored parts of the globe. The task has been one of years. Difficulties of the worst sort have been met in getting material and transporting it, setting it up properly and then in operating the systems established.

From Eagle, near Dawson, to Valdez, a distance of about 400 miles, the line follows the government trail. This part was particularly hard to install, but the line down the Tanana was even more so. It was necessary to string the wires along the surface of the deep snow in the winter and elevate them to poles in the summer, for the ground in many places is so soft when the sun melts the snow that travel over it is most difficult. Then the long stretch down the Yukon to St. Michael—about 800 miles—was a sore drain on the energies and resources of the signal service parties detailed to the arduous duty.

Keeping the lines up through the wild country, where storms rage and perils of all sorts threaten, is no easy task, for hundreds of miles of wires have been prostrated at a time, and parts of the line have been down weeks and months at a time, just when it seemed all was complete. A fierce forest fire in the Tanana valley burned down thousands of newly erected poles when the signal service was ready to announce the completion of the land system.

To overcome the difficulties of wire communication General Greely has been trying for two years to install a wireless system through the rougher parts of the country, up from St. Michael and through the Tanana, and as a result the faith of the chief signal officer is sadly shaken in wireless systems. At least, he says, he wants something more than promises. His contracts have been broken and his attempts to secure connection between far separated points without the intervention of metal have met with failure and discouragement.

Apparatus in huge quantities have been shipped northward by various companies having contracts with the government. Fearing they would be unable to secure proper timber for masts at the wireless stations, long timbers were shipped by boat from the States to be transported up the rivers far from the coast. Last year the season for work was too short, it was argued, to accomplish much, but this year it is hoped to do more toward supplanting the wire with the wireless system.

Right at Nome the most baffling discouragements have been encountered. With St. Michael in communication with the outside world for the greater part of the winter, Nome was several days further away, though only across the sound. It would seem that the laying of a cable across this short gap might be accomplished without much hardship, but for at least half the year the water is frozen and the ice snaps the metal like a straw. Messages must cross from Nome to St. Michael by courier. Several attempts have been made to talk between the two places without wires, but only the faintest impulses have been transmitted, and those flitting and of no value. Something was always the matter with the sending or the receiving apparatus. But by October General Greely really expects to see this link in the system completed, for there is no good reason why this short space might not be bridged successfully. In the interior, mountain ranges between the stations have proved very serious obstacles.

Two hundred tons of cable have been received as part of the 700 miles to go between Valdez and Skagway, and there is little doubt but that this part of the work will be completed within a few months. The cable used is of domestic manufacture, and this is a matter of pride with General Greely, for almost all the cable used in the world has been manufactured in England and France. By the end of this year the United States government will have 3,500 miles of cable laid, making it the second government in number of miles of submarine wire, France's lines amounting to 5,054 miles. Germany has 2,636 miles, Great Britain and Ireland 2,074, Japan 2,022 and British India 1,060 miles. These figures do not include private or semi-private lines.

The work of laying the Alaska cable has been in charge of Colonel James Allen, of the signal corps. Captain Charles Stuart Wallace, recently assigned to the Burnside, is a brother of the recently appointed chief engineer of the Panama canal. Mr. David Lynch, an expert cable operator, of New York, is the electrician. Henry Winter, a United States cable engineer, is also of this staff.

In recognition of the splendid work accomplished by the signal service in Alaska and the cable laying, a public banquet is to be given in October under the direction of the Seattle Chamber of Commerce. An effort will be made to have President Roosevelt, Secretary Taft, ex-Secretary Root, who has been particularly favorable to the undertaking, and General Greely present.—*Telegraph Age, August* 1.

The Northwestern Electrical Association.

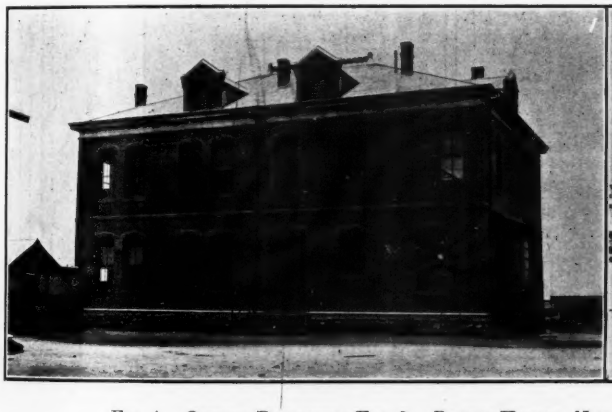
During the week of September 12-16, 1904, the headquarters of the Northwestern Electrical Association will be at the Forest Park University Hotel, St. Louis, Mo. The annual convention will be held during this time, which, as is well known, is the week of the International Electrical Congress. Mr. Thomas R. Mercein, 85 Michigan street, Milwaukee, Wis., the secretary of the association, will be pleased to correspond with any member who contemplates attendance on the convention.

Power Equipment of the New Shops of the Mexican Central Railway Company, Limited, Aguascalientes, Mexico.

By R. M. Henderson.

THE consolidation of the Mexico City and San Luis Potosi shops of the Mexican Central Railway into one general repair shop at Aguascalientes has practically been accomplished, and the headquarters of the mechanical department have been moved from Mexico City to the latter place; Aguascalientes, being at the junction of the Mexico and San Luis divisions, is the ideal location for a general shop and a centre for material distribution to the entire system. The two old shops had been found insufficient to handle the repairs incident to a greatly increased equipment, and their consolidation has been brought about for the purpose of securing a better economy together with increased facilities and greater capacity. Very few new machine tools have been purchased, but a much larger output from the old ones has been secured by a judicious arrangement of them and the provision of better facilities for handling the work.

The design and construction of the buildings have been under the care of Mr. Lewis Kingman, chief engineer, and Mr. H. Bentele, assistant chief engineer, while Mr. Ben Johnson, superintendent of machinery, assisted by Mr. C. T. Bayless, mechanical engineer, and Mr. R. M. Henderson, electrical engineer, has had complete charge of the design and installation of the power plant and the equipment of the shops. The actual work of installation of the power-house machinery and cranes, and the wiring for power distribution was done by contract with the D'Olier Engineering Company, Philadelphia, but under the supervision of the mechanical department of the railroad.



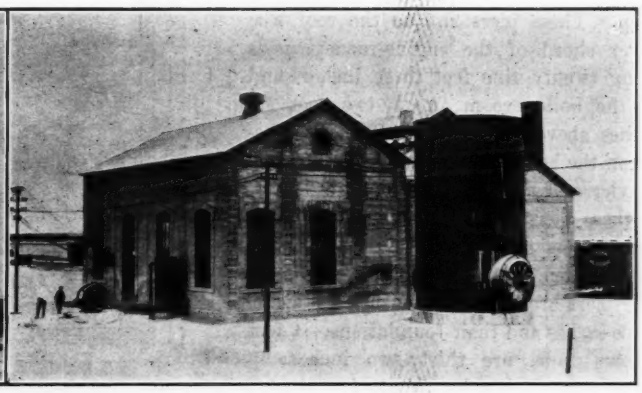


FIG. 1.—OFFICE BUILDING; FIG. 2.—POWER-HOUSE, MEXICAN CENTRAL RAILROAD, AT AGUASCALIENTES, MEXICO.

THE POWER PLANT.

Even the most conservative of modern engineers believe in the centralization of power in industrial plants covering considerable territory. These shops, together with the company's timber-preserving plant, constitute the largest railway shops in Mexico. In accordance with the best modern practice, all the power required for all branches of the plant is generated in one building and a system of electrical, steam and compressed air distribution delivers the power to the local points of consumption with a minimum loss in transmission. The theoretical centre of distribution from the standpoint of electrical power consumption, was taken for the location of the generating plant, which has ample power capacity both for motors and the future lighting system. From this advantageous location the current is carried by overhead conductors to the different shop buildings; steam is delivered to the smith and hammer shop and the rolling mill through a pipe line located in underground conduits, and compressed air is delivered to all the shops through an underground pipe system with reservoirs above ground at such intervals that there is little chance that the local pressure can be materially diminished by a sudden or unusual demand at any place on the line. From the steam turbine down to the permanent boiler and coal-testing apparatus, all of the details of the building and mechanical and electrical appliances are thoroughly modern and in line with first-class engineering practice as modified by local soil and climatic conditions and the cheapness of native labor.

BUILDING.

Like the other shop buildings, the power-house is of very plain and substantial appearance, being built of concrete and rubble masonry. (See Fig. 2.) Unlike most of the other buildings, the walls are carried down to the ground. In this latitude and altitude there is practically no frost, the ground never freezes, the average temperature being about fifty-five degrees Fahrenheit throughout the year, and the rainfall is confined to a short season. The soil is of a peculiar formation, particularly well adapted to foundation and building purposes. There is a surface stratum of loose structure which varies in thickness from an inch to three feet. Below this is "tepetate" to a great depth. This tepetate is extremely solid, and in digging, an ordinary pick makes almost no impression. A bar and heavy sledge is the regular equipment, and blasting is resorted to many times. With such soil and climatic conditions, foundations may be lighter and the questions of heat and cold may be omitted in considering the superstructure as well as the foundations. The three factors which rendered solid walls necessary for the power-house are the sand storms which prevail from January till June, the rains from June till October, and stealing. This last is fully as important as the former.

As in the case of the other buildings, a skeleton structure of solid concrete piers

supports the roof trusses and forms the framework of the building. Where solid walls were desired they were made by filling in between these piers with lime concrete. The north wall is temporary to allow for future extension, as shown in Fig. 3, and is built of adobe, faced with cement, in imitation of cut stone, and reenforced by brick piers.

Ample daylight lighting is provided by large windows in the engine-room walls, and in the boiler room, the entire east side is open between the piers clear to the roof, except in one bay which has since been closed in with corrugated galvanized iron, to protect the belting of the mechanical draught apparatus from rain.

The foundations for the outside engine-room walls and the north and south boiler-room walls extend two feet below the grade line and rest on hard tepetate. The concrete piers, composed of one part Alsen Portland cement and eight parts fine broken stone, are twenty-six inches square and are set on a base thirty-two inches square and twenty-four inches deep. These piers rise to the roof, the lower chord of the engine-room trusses being twenty-nine feet three inches, and of the boiler room twenty-two feet six inches above the ground. The piers between the boiler and the engine rooms are heavier and their foundations are deeper, as these piers support the roof trusses of both rooms and reenforce the steel columns which carry the engine-room crane. The piers are twenty-six inches by thirty-three inches and their foundations, six feet below grade, are thirty-two inches by thirty-nine inches by twenty-four inches thick. On account of the longer span and consequently heavier trusses in the boiler room, the piers of the east and open wall of the boiler room are carried four feet below grade, and are twenty-six inches square on a twenty-nine-inch square base which is supported by thirty-five-inch square foundation blocks.

Between the concrete piers the walls of lime concrete are carried to the same depth as the piers, and after the forms were removed the entire surface, inside and out, was finished with a cement wash. All the walls are sixteen inches thick except the temporary adobe wall which is twenty inches thick. Between the piers on the open side of the boiler room a sixteen-inch rubble wall is carried up to within six inches of the floor level and a coping of cement concrete finishes it even with the floor.

The surface drainage is excellent, and as water is not found in the region of the yard at less than 175 feet in depth, no special preparation for a floor with a view to eliminating moisture from below is necessary. The loose surface loam was cleared off to the tepetate, and more tepetate filled in and tamped wet to within twelve inches of the floor level. Above this was concrete, mixed in the proportion of one part Alsen Portland cement, three parts clean sharp sand and six parts of broken stone. A cement finish one inch thick, of one part cement and one part sand, completed the floor. This floor is used throughout the power-house except in front of the boilers. At this place, tepetate was filled in and tamped wet to within six inches of floor level. The same mixture of concrete extends five and one-half inches. Twelve hours was allowed for partial drying and then one-half inch cast-iron plates thirty-six inches square were laid and set with a slight filling of neat cement.

In the northeast corner of the engine room is the condenser pit, thirty-five feet by fifteen feet by fifteen feet deep, and in the boiler room is a pit of the same depth for the main boiler feed pump and the centrifugal pump of the boiler test apparatus. The building walls were carried to the level of the bottom of the condenser pit, on two sides, and brick retaining-walls complete the other sides. Similar walls complete the pump pit. A door in the partition wall between engine and boiler rooms connects the two pits. The floors are of concrete, six inches

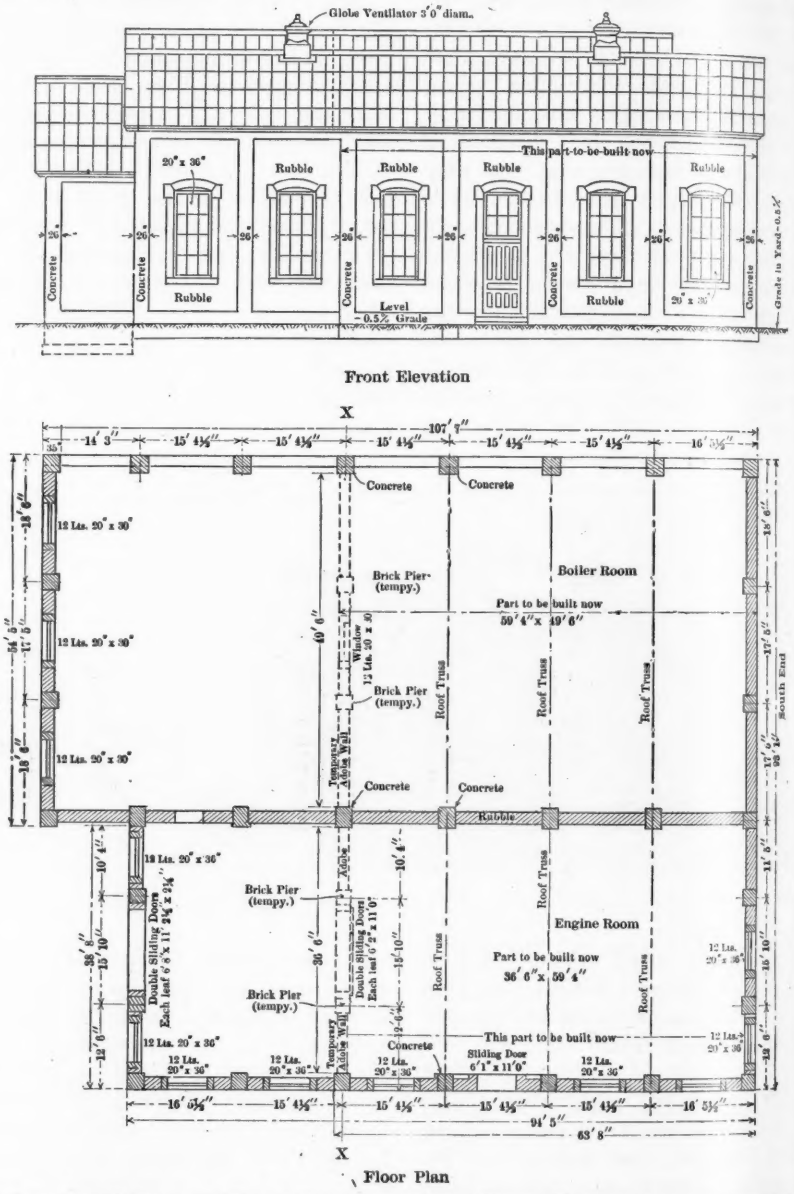


FIG. 3.—FLOOR PLAN AND FRONT ELEVATION, POWER-HOUSE, MEXICAN CENTRAL RAILROAD, AGUASCALIENTES, MEXICO.

thick on the tepetate, in its natural state. In one corner of the condenser pit is the hot well, a cement-lined pit ten feet by five feet by five feet deep. Another small pit in the centre of the condenser pit, and directly under the condenser, is for the accommodation of a small pump which will be described later.

Except in the coach paint shop and power-house there are no structural steel roofs. In these two buildings the higher fire risk made it advisable to use incombustible material. There is never sufficient cold to cause condensation and dripping, with the attendant liability of injury to the electrical apparatus, so that it was decided to make the roof of metal throughout. The trusses are of light triangular form and one-quarter pitch, built up of steel angles. The purlins are of Z-bars. Corrugated galvanized iron, fastened to the purlins with special galvanized clips, completes the floor.

The outer slopes of the engine and boiler-room roofs drain directly to the ground, which slopes away from the building. A gutter drains the inner slopes to a header which discharges on the ground. A globe ventilator surmounts the engine-room gable, and a side opening ventilator extends over five bays of the boiler-room roof, directly above the boilers.

The boilers are hand-fired and the coal and ashes are handled manually. The coal and ash-handlers in the boiler room are paid fifty cents Mexican currency (twenty-two cents United States currency) per day; firemen seventy-five cents Mexican (thirty-four cents United States), and head firemen $1 Mexican (forty-four cents United States). Coal is unloaded from the cars at $1.50 per car and ashes loaded at the same cost. At the present shop load of about 175 kilowatts, all the coal used is handled from the car, through the bin, boilers, ashpits, and back to the ash car for $2.50 Mexican ($1.14 United States) per day, which is equal to $0.00143 Mexican ($0.00065 United States) per kilowatt-hour. Thus it is exceedingly doubtful if there would be any economy in installing coal-conveying machinery and mechanical stokers, or even elevated coal bunkers. Accordingly a coal bin was built on the ground abutting the north wall of the boiler room and fronting the track east of the building. An arched door leads directly from the bin to the front of the boilers. The walls of the bin are of heavy masonry eight feet high, and the capacity of the bin is 200 tons.

EQUIPMENT.

Water is never over plentiful and during the latter part of the dry season is exceedingly scarce at times, so that every possible means and mechanical device has been utilized for reclaiming every available pound of water. Strictly high-grade apparatus is used throughout, and in selecting, preference was given to types which would require a minimum of skilled attendance.

THE BOILERS.

The steam plant consists of three 250-horse-power Babcock & Wilcox wrought-steel sectional water-tube boilers of the horizontal, inclined tube type, set in one and one-half batteries. Each boiler is composed of twelve sections of tubes, each section containing ten lap-welded wrought-iron tubes, four inches in diameter and eighteen feet long, expanded at the ends into continuous wrought-steel, staggered headers. Hand holes opposite the ends of each tube permit the cleaning, removal and renewal of any tube, and each hand hole is covered with a cap, fastened with a wrought-iron bolt, clamp and cap nut. The sections of tubes are connected at each end to the two steam and water

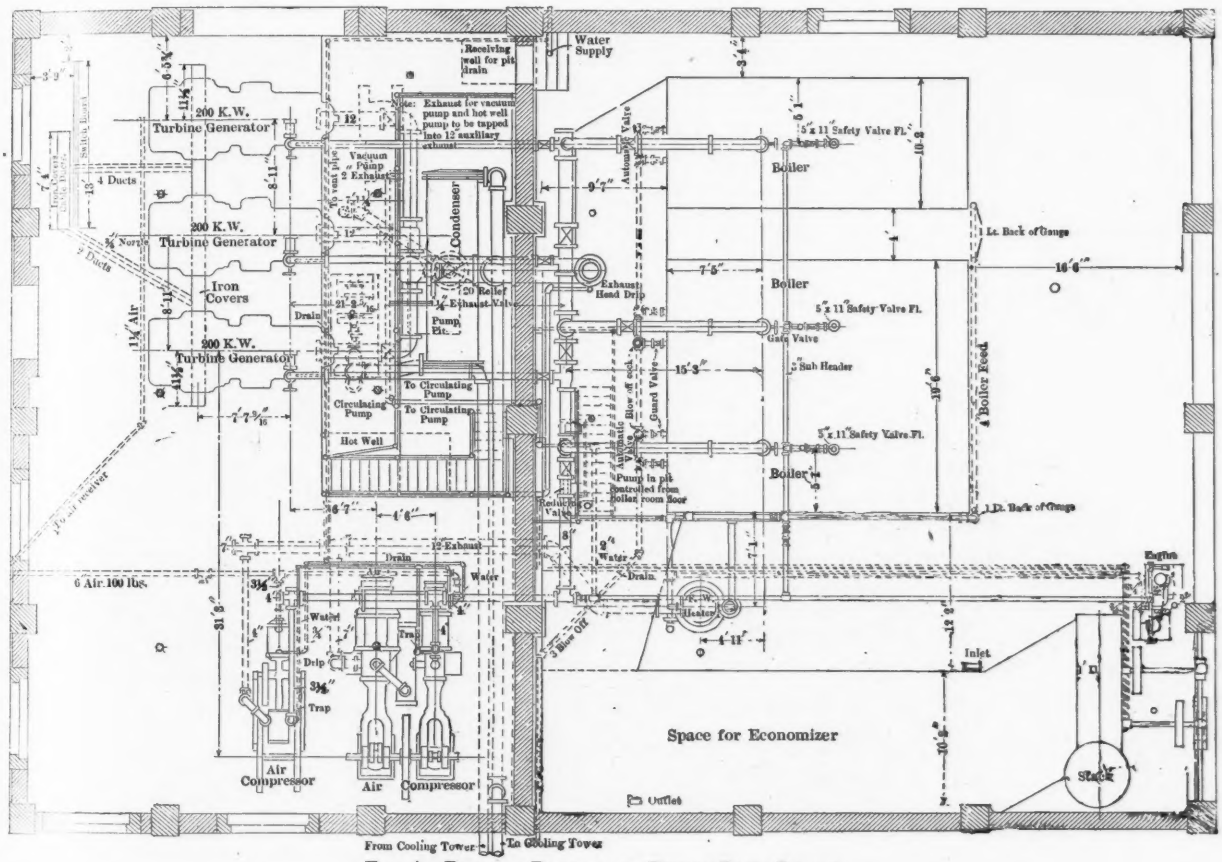


FIG. 4.—PLAN OF BOILER AND ENGINE-ROOM LAYOUT.

drums, and at the lower rear end to the mud drum by means of four-inch lap-welded wrought-iron tubes, the joints being expanded.

The steam and water drums are thirty-six inches in diameter and twenty-three feet three and five-eighths inches long. Each drum is provided with a manhole at one end and with two nozzles. The forward four-inch nozzle connects to the consolidated N. S. safety valves, four inches diameter and set to blow at 200 pounds pressure. Between the safety valve and the nozzle of one drum of each boiler is a connection to a three-inch auxiliary steam header which supplies saturated steam through a reducing valve to the boiler auxiliaries, and, if so desired, to the air compressors. The rear nozzles, eight inches in diameter, supply superheated steam to the main steam header.

Each boiler is equipped with a Babcock & Wilcox superheater with 264 square feet heating surface which superheats the steam 100 degrees to 120 degrees Fahrenheit. The water columns, also Babcock & Wilcox, are large sized and fitted with automatic closing valves and safety gauge-glass valves which may be closed from the floor.

The total heating surface of each boiler is 2,690 square feet and the grate area fifty-two square feet. This gives 51.7 square feet of heating surface and 5.08 square feet of superheating surface per square foot of grate area.

The space occupied by one battery, including the brickwork, is twenty-three feet five inches long and nineteen feet six inches wide on the floor line, and sixteen feet two inches high to the top of the steam flange. The three boilers required for the setting, exclusive of the foundations and flues, 61,400 common bricks and 123,000 firebricks. The feed-water and superheater piping and fittings are of extra heavy brass. The two south boilers are equipped with thermometers, thermometer wells, draught gauges, pyrometers, etc., for operating the coal test, and a test is run nearly every working day on one boiler. In the other boiler, the shavings from the planing mill are burned.

Referring to Figs. 4 and 5, the flue, which is of sufficient capacity for 1,500 boiler-horse-power, takes the gases of all the boilers. The present flue will be a by-pass to the future economizer, so that access may be had to the economizer without interfering with the operation of the plant. Space has been left for the economizer, and proper outlets have been left in the feed piping for the connections. At present the by-pass connection constitutes the only flue and leads directly through the fans of the induced draught apparatus to the stack, which is five feet in diameter and twenty-seven feet long from the top of the fan housing.

MECHANICAL DRAUGHT APPARATUS.

The B. F. Sturtevant Company supplied the induced draught equipment, which consists of two heavy steel fans arranged in a vertical tandem manner, the lower fan being three-quarters housed and the upper fan housed. (See Fig. 6.) The wheels are of the overhung type mounted on four-inch shafts, and each fan is capable of maintaining a draught pressure in the flue connection of each boiler equal to three-quarters of an inch of water, when handling all the gases of combustion from the burning of 3,500 pounds of coal per hour, with a flue temperature of 600 degrees Fahrenheit, and operating at a peripheral speed of fan wheel not exceeding 7,000 linear feet per minute. The ring-oiled fan bearings are of liberal proportions and water-jacketed, excepting the outboard bearings which are not subjected to external heat.

A counterbalanced sliding damper permits the cutting off of either fan from the flues, or both may be operated at the same time. Each fan is operated by a Sturtevant vertical simple engine belted to the fan. These engines will operate on twenty pounds of steam, and as the natural draught is always sufficient to develop this pressure, the draught can always be

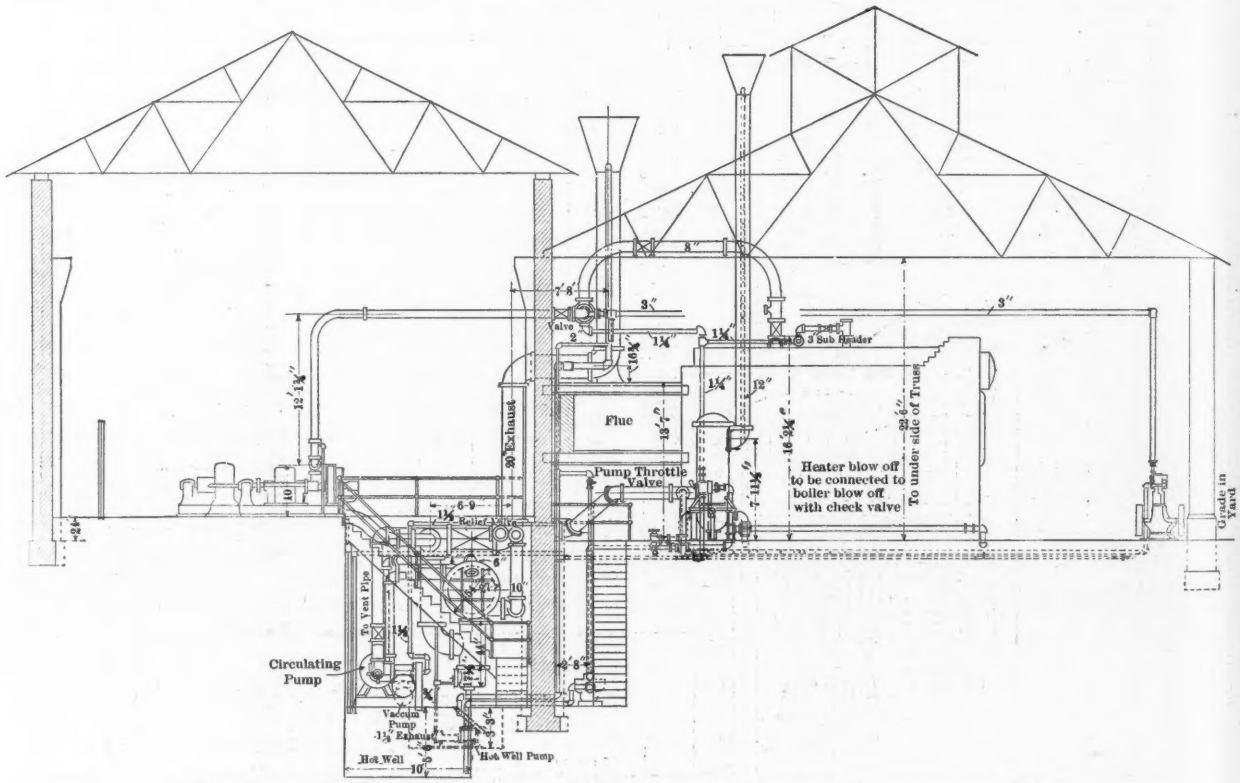


FIG. 5.—BOILER AND ENGINE-ROOM LAYOUT, MEXICAN CENTRAL RAILROAD, AGUASCALIENTES, MEXICO.

started and maintained independent of the electrical apparatus and its troubles, or the compressors run and steam supplied for outside purposes without running the dynamos.

Each engine is controlled by a fly-ball governing and also a regulating valve which automatically controls the steam pressure within limits of eight or ten pounds under the widest fluctuations of load to which the boilers have been subjected.

BOILER FEED SYSTEM.

There are three independent systems of supplying feed water to the boilers. The main feed pump is a seven and one-half inch by five-inch by six-inch Knowles of the simple duplex type with outside packed plungers and heavy pot valves. The steam cylinder is designed for high-pressure steam which is taken from the three-inch saturated steam header at full boiler pressure. The pump is provided with a two-inch brass water-relief valve, is brass fitted throughout, and can handle 2,500 gallons of water per hour against a thirty-foot head and 200-pound boiler pressure. The suction is supplied from the hot well, and the discharge is passed through the feed-water heater before entering the boilers. The heater is of the Wheeler closed type with straight brass tubes and removable heads, the capacity being 750 horse-power with 250 square feet heating surface. A by-pass in the feed piping permits the heater being cut out of service if necessary. With the limited amount of exhaust steam available this heater gives an average temperature within forty degrees of the boiling point.

The second system of feed-water supply is the boiler test system. The piping is entirely independent of the main system and the valves controlling the water of the two systems are located on the front of the boilers. A small motor-driven centrifugal pump takes water from the hot well and delivers it to two measuring tanks (see Fig. 7) of approximately 132 gallons capacity. From these two tanks the water gravitates to a third tank whose capacity is four of the measuring tanks. A six-inch by three and one-half inch by six-inch Knowles pump of the same type as the main feed pump passes this measured water through a smaller Wheeler feed-water heater into the boilers. In emergencies the measuring tanks may also be supplied directly from the water mains. The steam supply for the test feed pump is taken from a reduced pressure header leading to the fan engines. This header may be fed by either the main steam header or the three-inch saturated steam header, and it is a continuation of the header which supplies the air compressors.

A third system of feed is by means of a No. 8 Friedmen injector which takes steam from the saturated steam header at full boiler pressure and takes water directly from the mains.

On account of the frequent water famines which last from one to five hours during the last of the dry season, it was found necessary to erect a small emergency water tank at the power-house. This 4,700-gallon tank is located on top of one corner of the coal bin and will tide over a six or eight-hour water famine.

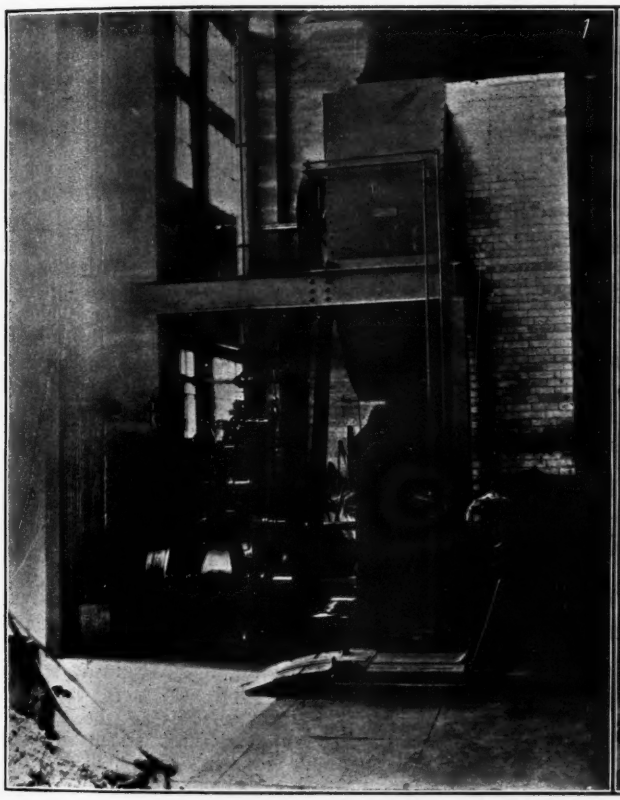


FIG. 6.—MECHANICAL DRAUGHT APPARATUS.

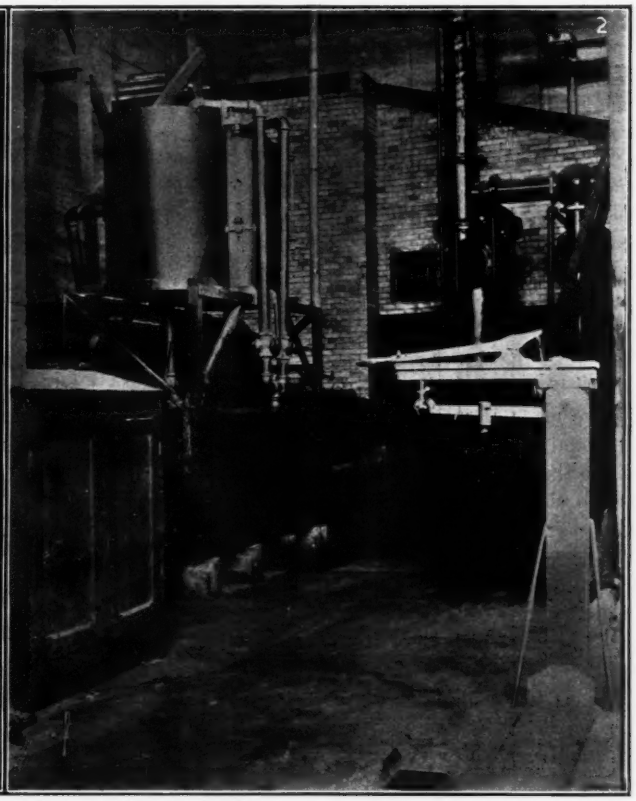


FIG. 7.—FEED-WATER HEATERS AND TEST TANKS.

TURBINES.

The present generating equipment is expected to care for the needs of the entire plant, with its expansion, for some years to come. The plant now consists of three 300-horse-power De Laval steam turbines, fitted with De Laval centrifugal governors and direct connected to a 200-kilowatt Milwaukee multipolar direct-current dynamo. Under the guarantee, the turbines operate with 200 pounds steam pressure at the governor valve, equivalent of twenty-seven inches vacuum at this altitude (6,200 feet), 100 degrees Fahrenheit superheat, and at 10,500 revolutions per minute with a

speed regulation of two per cent from no load to full load. Two spiral tooth pinions made solid with the flexible turbine shaft, with their teeth set in two rows at an angle of ninety degrees to each other, mesh with gears mounted on the two main shafts which are connected to the dynamo shafts by flexible couplings and reduce the armature speed to 900 revolutions per minute. The overload guarantee is twenty-five per cent. Acceptance tests were made at the De Laval factory under the inspection of the railway company's electrical engineer and later tests were made after the machines had been operating under shop load for several months, and the machines came well within the guarantee in every respect.

The steam consumption guarantees per brake-horse-power: full load, 14.6 pounds; three-fourths load, 15.1 pounds; one-half load, 16.1 pounds; one-fourth load, 19 pounds. With such economy on the lower range of loads it was not considered necessary to install a smaller unit to care for the night or lighting loads.

A closed gravity oil system supplies the high-speed bearings and the gear cases, while the slower speed bearings and dynamo bearings are ring-oiled. All bearings are made of special high-speed bearing metal, are interchangeable and are split so they can be removed without lifting the shafts from position. The outboard bearing of the turbine shaft is water-jacketed and the overflow pipe is broken so the water is visible for about six inches as it falls into a funnel in the overflow main which leads from the three turbines to the hot well. The overflow oil drains to an oil filter of the "Cross" type which is located in the condenser pit, and from which it can be returned as desired to the supply tank.

CONDENSING PLANT.

No cylinder oil is used and there is no oil in the exhaust steam which makes it possible to use a surface condenser. It was originally intended to use a single Cosmopolitan condenser which, with its fan and vacuum pump, would combine the function of a condenser, cooling tower and auxiliary to the mechanical draught apparatus. The failure of the Cosmopolitan Power Company about three weeks before the completion of the condenser made it necessary to alter this part of the plant. Subsequently an Alberger condensing plant was installed capable of condensing 20,000 pounds of steam per hour under the existing atmospheric conditions with the exception of the cooling tower which is of sufficient size to cool the condensing water when condensing 40,000 pounds of steam per hour. The entire condensing plant is so designed and constructed that it may be increased to double its present capacity when the building is completed and additional generating units are installed, without displacing any of the original equipment. The size 24 Alberger condenser is supported on concrete piers and connected to the exhaust steam main below the relief valve. The condensed steam is returned to the hot well by a simple duplex steam pump. This pump, which is a five and one-quarter inch by four and three-quarter inch by five-inch Alberger, is located in a small pit just below the condenser and is automatically controlled by a valve in the steam line, which is actuated by a float valve in the reservoir compartment of the condenser. This effectuallv protects the dry vacuum pump from being flooded by the accumulation of condensed steam.

The vacuum is maintained by a steam-driven eight-inch by sixteen-inch by twelve-inch Alberger flywheel dry vacuum pump. A two-inch steam pipe tapped into the low-pressure steam header supplies these two pumps, and their exhaust is carried to the auxiliary exhaust main which passes through the feed-water heater.

The circulating water is handled by a centrifugal pump with ten-inch supply and discharge pipes, built by the Kingsford Foundry and Machine Company, of Oswego, N. Y., and connected by a flexible shaft coupling to a thirty-horse-power Crocker-Wheeler shunt-wound motor. Both motor and pump are securely bolted to a single heavy cast-iron bed-plate so that the alignment of the shafts will be permanent. Thermometers conveniently located in the ten-inch discharge and suction pipes show at a glance whether the circulating water is being properly cooled. The Alberger cooling tower is located just south of the power-house. It is thirty-two feet high and nineteen feet in diameter, and the walls of a concrete reservoir five feet deep form its foundation. Two eight-foot fans at the bottom drive a current of air up through the four-inch square spaces between the crossed courses of three-quarter-inch cypress boards set on edge, which constitute the cooling surface. The ten-inch discharge pipe from the condenser ends in a sprinkler head about five feet below the top of the tower, the force of the water operating this head which revolves slowly and gives an even distribution of the discharged water over the entire area of the tower. The shaft on which the fans are mounted extends through a wall bearing into the engine room, and is belted to a thirty-horse-power Crocker-Wheeler shunt motor mounted on a bracket on the wall above. Both this motor and the one driving the circulating pump have their panel-boards on the walls of the engine room, so that they can be started up again quickly in case the main circuit-breakers are thrown out.

The condenser, with its auxiliaries, makes an exceedingly compact group, as the 900 horse-power is cared for in a floor space fifteen feet by twenty-five feet, excluding the cooling tower.

AIR COMPRESSORS.

The main air compressor is of the duplex, two-stage, horizontal, cross-compound, direct-connected, flywheel type with separate intercooler and receiver. It is the forked frame type, built by the Laidlow, Dunn-Gordon Company, of Cincinnati, and has steam cylinders fifteen inches by twenty-four inches by eighteen inches, and air cylinders twenty-four inches by fourteen inches by eighteen inches, and a flywheel seventy-six inches in diameter, with rim five inches by twelve inches. With 125 pounds steam pressure and 120 revolutions per minute, it has a capacity for compressing to 100 pounds per square inch. At an altitude of 6,500 feet the weight of air is equivalent to 800 cubic feet of free air per minute at sea level.

The compressor is equipped with the Meyer adjustable cut-off valve gear, and is provided with a combined speed governor and air regulator, which maintains a constant speed until the air pressure exceeds the predetermined reservoir pressure, at which point it reduces the speed and then increases it again to the normal as the reservoir pressure drops. Both steam and air cylinders have adjustable automatic sight-feed lubricators.

The intercooler is of the cylindrical water tubular type, seventy-five small straight brass tubes supplying the cooling surface. The air cylinders are water-jacketed, being in the same circuit with the intercooler, and the cooling water is discharged into the hot well to be used for boiler feed.

As an auxiliary to the main compressor is a "straight line," class "A," Ingersoll-Sergeant No. 7 air compressor. This is a single-stage type with steam cylinder fourteen inches by eighteen inches and air cylinder fourteen and one-quarter inches by eighteen inches, and when running 120 revolutions per minute has a capacity for compressing to a pressure of 100 pounds per square inch a weight of air equal to 382 cubic feet of free air per minute at sea level. It is also provided with the Meyer adjustable cut-off valve-gear, and a speed governor and pressure regulator. The air cylinder is water-jacketed, and the jacket water is discharged into the hot well.

(To be concluded.)

APPLICATION OF ELECTRICITY TO STEAM ROADS.[1]

BY L. S. RANDOLPH.

The very successful application of electricity to the trolley systems of the world has lead to the discussion of the question to what extent is it applicable to the steam roads with their mixed service of freight and passenger and their more powerful units with a less number in service.

With the steam roads all are familiar, so that a discussion of same would be useless.

Of the electrical systems now available we have the plain, direct-current system now used for trolley roads all over the world. In this system the power is applied sometimes directly to the wheels of the vehicle carrying the load as in the case of the ordinary trolley car, and at other times a motor or locomotive is used which takes the place of the ordinary locomotive, direct current being used in both cases.

The alternating-current system has been used, having a step-down transformer carrying the current as alternating current to the motor. This system is in the experimental stage, and it can hardly be said to be sufficiently promising to warrant consideration, except for light trolley service.

Another alternating-current system has, at intervals along the road, motor-dynamos which obtain their power from the alternating system and furnish a direct current to the trolley or feed wires.

Still another is the Arnold system, which is similar to the first except that the problem of transmitting the power to the wheels has been solved in a somewhat different manner, instead of friction clutches or some form of motor which attempts to use a single-phase alternating current either by splitting the phase or other method, the Arnold system has a single-phase alternating-current motor driving an air compressor, the compressed air from which is stored in large drums on the machine, and these in turn operated compressed air locomotive to start the motor or run through cities and towns. This system has all of the disadvantages, except dirt and dust, which the locomotive has, together with all the disadvantages of the air-compressing plant piled on top of it.

It is evident from a careful study of these systems that something other than an alternating current must be used on the motor unless some one invents an alternating-current motor which is self-starting, with a capacity for a large initial torque, which can hardly be said to have been done at least in a commercial way.

Two methods of transmitting power to a moving vehicle are available:

First. Storage of power at intervals on the vehicle, usually during stops and transforming the potential energy into kinetic while in motion.

Second. Transmission to and transforming on, while the machine is in motion.

In the first class is included the locomotive and all forms of the automobile, whose travel is over long distances or irregular paths, including the storage battery electrical car, and the compressed air car. In all of these the power is stored during stops of greater or less duration and transformed into kinetic energy while the car is in motion.

In the second class are included all those motors in which the energy is transmitted while the machine is in motion; this should include the electrical trolley system for long distances and for short distances electrical compressed air, hydraulic and running rope systems of transmission as in the case of cranes, gantrys, etc.

So far, electricity is the only practicable system for the transmission of power to a moving vehicle where the path of a vehicle is extended to any great distance, the limits set by all other methods of transmitting to a moving vehicle being two to three hundred feet.

The problem to be discussed is:

First. Is it more advantageous to store power on the moving vehicle or to transmit it to the vehicle while in motion?

Second. What are the advantages and disadvantages of machines and appliances inherent to the two systems, and in what way and to what extent do those affect the solution as a business proposition and at what point and under what conditions is the one superior to the other?

It is assumed that for long distances and light traffic the steam road is superior to the electric road, but that for short distances and heavy traffic the probability is that the electrical method is the best.

There are certain advantages and disadvantages which are not capable of being expressed in dollars and cents which must be considered, and which may entirely alter the solution of the problem. These are as follows:

Advantages of the steam locomotive system:

(*a*) Separate units, one of which failing does not cripple the system or a section of the system.

(*b*) Units can be put out or in service readily as the traffic demands; that is, the capacity of the steam road can be doubled by borrowing or purchasing for prompt delivery double the number of locomotives; whereas, the electrical system will require the increase of the capacity of the power-houses and transmission line along the way, besides doubling the number of motors.

(*c*) Thoroughly independent, the unit being self-contained in every respect, this system can be operated as long as the track stays in position.

Advantages of the electrical system:

(*a*) Uniform rotative effort or torque gives greater tractive effort and reduces the wear and tear due to the slipping and spinning wheels, thus increasing the life of the motor. It is estimated that the increased tractive effort amounts to ten to fifteen per cent. No figures are available to show the increased life of the motor.

(*b*) The higher rotative speeds which are readily obtained make it possible to use smaller wheels, and the absence of unbalanced rotating and reciprocating parts permits these speeds to be attempted without serious damage to track or machines, thus reducing the weight of the engine or motor to simply that required to be put on the driving wheels for tractive purposes, and make it possible also for some systems to do without the motor entirely, driving from the wheels and axles of the moving vehicles which carry load. This is now being done in two or more very successful cases. It is impossible to say what effect this will have on the cost and maintenance of track. The writer would put the saving at ten per cent. It would also largely reduce the strain on bridges and trestles and the roadbed in general.

(*c*) Where the path of the return current is from the driver to the rails a considerable increase in tractive effort is obtained above that due to the weight alone. This amount is not definitely known.

(*d*) Freedom from dirt, smoke and cinders.

(*e*) Simplicity of machine and rapidity with which repairs can be made on the motor.

(*f*) Can be put in service instantly and no delay is incurred waiting to get steam up.

(*g*) Break down of individual motors is not so likely to occur. The writer estimates the number of breakdowns would

[1] Paper presented before the Richmond Railroad Club, May 12, 1904.

be lessened by half, and as from six per cent to eight per cent of the detentions on steam roads are chargeable to locomotive failures, the substitution of the electric motor would save three per cent to four per cent of the time now lost on railroads.

The disadvantages of the locomotive:

(*a*) Limited accelerating forces at starting, hence loss of time in getting away from stations.

(*b*) Tractive power at starting limited; the maximum tractive effort not being attainable on account of the unequal rotative effort of the present type of locomotive. What will be the result with the application of the steam turbine to the locomotive is difficult to estimate.

(*c*) Dirty, dusty and disagreeable odors.

(*d*) Complicated machinery.

(*e*) Total power of the machine limited by the boiler capacity, particularly noticeable in passenger service.

(*f*) Excessive weight of machine due to the necessity of having large boiler and small wheels for guiding the machine on the track around curves and for sustaining the weight of additional boiler capacity, the distribution of the pressure on these wheels being irregular and in many cases excessive. Application of electric motors at this point will permit the equalization of the rail pressure between the different wheels. Application of the steam turbine would have the same effect.

Disadvantages of the electrical system:

(*a*) Failure of power of medium of communication, as trolleys, wire feeders, etc., may cause the throwing of the whole division, or section, out of service. The destruction of a power-house or a boiler explosion would tie up an entire system.

(*b*) Motors can not be readily repaired on the road, and a breakdown, when it does occur, is more apt to be serious than with the locomotive. This objection is open to very serious question, as the electric locomotive may have separate motors on each axle, which would admit of one being cut out at any time should it fail or burn out, leaving the others in service. Such repairs as this can be done more quickly than taking down one side of a locomotive in case of the failure of the other side, but a breakdown to the controlling device, trolley connection, etc., would place the machine out of service.

(*c*) Full power must be kept up at the central station regardless of the number of motors drawing current therefrom, it being, to a certain extent, impracticable to vary the station output with the demand for current. This can be questioned as it would be possible to raise steam on boilers just as locomotives are now got ready to handle an anticipated run of freight.

(*d*) Capacity of the system is not readily or quickly increased so as to handle an increase of traffic; that is, a bunched lot of trains on a system may readily disarrange and seriously overload the power-house, unless it is abnormally large.

(*e*) The blowing of a fuse or the throwing of a circuit-breaker may stop every train operated from a given power-house.

(*f*) Special trained mechanics are required for the work. This objection will not hold very much longer, as we are rapidly getting a well trained set of mechanics who handle electrical machinery very successfully; in fact, in many instances more successfully than they do locomotive repairs.

(*g*) The total capacity of any one system of railroads operated by electricity can not be readily or quickly increased. To double the capacity of a system requires the doubling of the number of motors and doubling the size and capacity of the power station, feeder wires, etc.; whereas, with the steam road the doubling of the number of locomotives settles the question entirely except the increased siding and yard capacity, which increase would be common to both systems.

The above advantages and disadvantages are such as can not be valued in dollars and cents in a general treatment of the subject, and only a few of them can be so valued in special cases, and these only with great difficulty. Of those whose relative value can be stated in dollars and cents only two can be handled in a general discussion of this kind, namely, the total first cost, the cost of the power delivered to the driving wheel and the relative cost of operating based upon the density of the traffic. The elements of cost of power delivered to the driving wheel would be in the locomotive as follows:

Coal, repairs, oil, waste, tallow, water, engineers' and firemen's wages, depreciation, insurance, taxes and interest.

We will take coal, repairs, engineers' and firemen's wages as different and affecting the calculation of the cost of power delivered to the driving wheel, the remainder being common to both the motor and the locomotive.

We will assume in calculating the cost of power delivered to the driving wheel, steam used per horse-power per hour, twenty-eight pounds; water evaporated by the boiler of the locomotive per pound of coal, eight, making three and one-half pounds of coal per horse-power per hour delivered at the driving wheel.

Engineers' and firemen's wages, on account of the simplicity of the electrical machinery, the cost of labor on the motor is very much less. It is assumed here that it will be out of the question to have one man only on the machine, although with some types of apparatus, such as the Sprague multiple unit, one motorman would be all that was necessary, the reason being that in case of an accident or serious illness to the motorman he could be readily reached by a conductor or brakeman; but when isolated, as the engineman and fireman are on the modern steam locomotives, and with the records we have of sudden illness or death of one or the other, it would be entirely impracticable to attempt to run a motor with one man alone unless the other members of the train crew had ready access to him.

With the Sprague system the fireman's wages would be reduced, and on account of the simplicity of the apparatus, the engineman's wages could be very much curtailed. The average rate of wages at the present time is for enginemen, four cents a mile, or, if we call 100 miles a day's run, four dollars per day; firemen, one-half that rate, making six dollars per day for both; whereas, in the electrical systems these figures could be reduced to three dollars a day if one motorman was used or four dollars and a half a day if two men were used, the second man taking the position of flagman or brakeman.

The question of interest, depreciation of plant, taxes, etc., can, under the above discussion, be taken practically as the same for motor and locomotive. The cost of the motor and its equipment, with the depreciation of the plant and taxes, may differ, but not to any serious extent. The cost of repairs can not be considered as equal. If we take the average cost of repairs for the locomotive as, say, five cents per mile, and that the average locomotive makes 50,000 miles per annum this will make $2,500 per year as the cost of repairs. If we take the cost of a locomotive at $12,500 apiece, this would be twenty per cent per annum as our repair bill. It is safe to assume that for the motor alone this repair bill would not be over five to eight per cent, making a difference in favor of the motor of $2,000

per annum. If we could separate our cost of repairs of locomotives into boiler and engine repairs and repairs to the running gear we could then simply charge the repairs to the running gear against the repairs to the motors, and the repairs to the boiler and engine parts against the repairs to the central station. As it is, we will be compelled to consider the items jointly.

The cost of coal per horse-power under the electrical system delivered at the driving wheel will be as follows:

Using a high rate engine, we will count on sixteen pounds of steam per horse-power per hour as the duty of the engine and ten pounds of steam per pound of coal as the duty of the boiler. This gives us one and six-tenths pounds of coal per horse-power per hour.

If we take the efficiency of the engine at eighty per cent, the efficiency of the dynamo at eighty-five per cent, the efficiency of the line at eighty per cent, and the efficiency of the motor transmission of machinery and all at seventy-seven per cent, we get a coal consumption of three eighty-two-one-hundredths pounds per horse-power per hour.

In discussing the question of central station, it is difficult to determine or include in the general discussion any figures as to what size they should be, and the best we can do here is to assume a standard case, thus indicating the method of solving the problem.

In determing the power required to be delivered by the station, we should, as is customary in the design of street railways and similar plants, add fifty per cent to the estimated requirements to obtain the capacity of the station. In other words, that if the maximum grade shows that 1,000 horse-power is demanded, 1,500 horse-power is installed, so that the machinery may be able in size and capacity to handle any excessive current caused by the bunching of a number of cars on some heavy grade.

As to the power required to haul a modern train, the average freight train seldom runs over 600 horse-power, whereas, the passenger trains frequently run at higher figures than this. The highest of which the writer has had personal experience is the test made by Mr. D. L. Barnes, of the Baltimore & Ohio, where 1,325 horse-power was developed. We may assume, however, that there may be required 1,000 horse-power per train at some portion of her trip. The peculiarities of the profile of the road will determine how much of this shall be required and how much shall be used in estimating the capacity of the power station. In other words, if we are building a station to handle ten trains over the division, if there is one sharp grade on the division or section which will require the full 1,000 horse-power, the other portion of the road may not require more than 500 horse-power for the train. The total requirements, therefore, would be nine trains of 500 horse-power each, or 4,500 horse-power with one train at 1,000, which makes a total of 5,500 horse-power.

Let us pause here for a moment to consider another feature of the problem, namely, the effect of distance or the total length of the road on the size of the power stations and the work which they have to accomplish. In the present state of the art it can be said that the direct-current systems are the only ones which are applicable to installations of the type which we have been discussing. So far the alternating-current systems are more or less matters of experimentation. We can safely say that in a direct-current system five miles each side of the power station is as far as the current should be carried on anything like heavy loads. It is true that for light loads it is perfectly feasible to carry the current ten miles each side of the station, using a booster on the outlying five-mile section. In a large installation it might be advisable to use the alternating-current system, having several stations, but using motor-dynamos on the substations every ten or five miles. In a section of road 100 miles long we could say, briefly, that the plan would be as follows:

In direct current, nine stations ten miles apart, or for light loads, five stations twenty miles apart, with boosters on every five-mile section or ten-booster installation for all.

With alternating current, two stations with motor-dynamo every five miles, making twenty in all, these feeding direct current into the ordinary trolley wire system.

While the following suggestion is not considered in these estimates, still there is little doubt in the writer's mind that the voltage in the direct-current system could be increased from the present standard of street railway work, from 500 volts to 1,000 volts, thus reducing the copper cost by three-fourths.

When it comes to the amount of current required and the number of trains to be fed, if we assume ten trains to each section of ten miles, we would have 100 trains in motion at a time, which would be very heavy double-track movement. This would give an average headway of trains of two miles and would be sufficient to blockade nearly any division which was operated without a large number of sidings, etc.

If, however, we are safe in considering that in any block or section of ten miles we may be required to run trains on two-mile headway, which would be five trains to the block, or, in double-track work, ten trains calling on the power-house for power at one time, this would give us our basis for calculating the power required, and it would enable us, with the profile of the road on hand, to figure very accurately what these ten trains would call for, and making the allowance of fifty per cent, as is customary in street railway practice, we would get the cost of the power-house for this section.

To obtain the first cost of the power plant for a ten-mile section, the following table has been calculated upon the assumption that a train will ordinarily take 800 horse-power, but may require 1,200 horse-power, and that two trains will take 750 horse-power each, ordinarily, but may take 1,125 horse-power each; that three trains will take 700 horse-power each, but may take 1,050 horse-power each; and that for all over three trains we will allow 500 horse-power each to cover the starting and running load, as it is not probable that more than three trains will be drawing on the power-house at one time for the maximum load which they are expected to need.

The cost of a power-house for a section of ten miles would be as follows:

Trains in a Block.	H.-P. Required on a Basis of Fifty Per Cent Excess.	Cost at $70 per Horse-Power.	Cost of Pole Line and Wire.	Total.
1	1,200	$84,000	$24,000	$108,000
2	2,250	157,000	44,000	201,500
3	3,150	220,500	60,000	280,500
4	3,650	255,500	72,000	327,500
5	4,150	290,500	82,000	370,500
6	4,650	325,500	92,000	417,500
7	5,150	360,500	101,000	461,500
8	5,650	395,500	112,000	502,500
9	6,150	430,500	122,000	552,500
10	6,650	465,000	132,000	597,500

In order to obtain the cost of the electric power we will assume first the cost of all operative charges other than the coal to be twenty-four dollars per horse-power per annum, the total charge being based on the total horse-power of the plant; that the cost of coal will be twenty-six dollars per horse-power per annum, but that the average horse-power will be only one-half of the capacity of the plant, making the cost per horse-power per annum twenty-four dollars, plus thirteen dollars (thirty-seven dollars), and that the interest, repairs and depreciation on the transmis-

sion system would be fifteen per cent. Under the above assumption the cost of operation of the power plant would be as follows:

No. of Trains per Block.	Cost of Power per Annum.	Cost of Operative Transmission System.	Total.
1	$44,400	$3,600	$48,000
2	83,250	6,600	89,850
4	116,500	9,000	125,500
3	135,000	10,800	145 800
5	153,500	12,300	165,800
6	172,000	13,800	185,800
7	190.500	15,200	205,700
8	207,500	16,800	224,300
9	226,500	18,400	244,960
10	246,000	19,800	265,800

In calculating the cost for steam locomotives we must consider that the charges are the same as for the electric locomotive except for coal, wages and repairs. At three and one-half pounds of coal per horse-power per hour, the cost of coal per year would be thirty-eight dollars. Taking the cost of repairs per annum per locomotive as previously estimated, we find the additional cost per locomotive to be over and above the electric motor as follows, the horse-power being the same as previously determined, *viz.*, one-half the maximum:

No. of Cars in Block.	Additional Cost per Annum of Repairs and Wages.	Cost per Annum of Coal.	Total.
1	$2,500	$22,900	$25,400
2	5,000	42,750	47,750
3	7,500	60,000	67,500
4	10,000	68,750	78,750
5	12,500	79,000	91.500
6	15,000	88,500	103.500
7	17,500	98.000	115,500
8	20,000	106,500	126,500
9	22,500	116,500	139,100
10	25,000	126,000	151,000

If we assume the expense of operating a motor by electricity and by steam to be the same, except as regards the cost of coal and the difference in the cost of the wages of the motormen, enginemen and firemen, we will have the additional cost of operation as that due to supplying the power when stored and generated on the engine, and when generated outside and transmitted to the motor by electricity. The relative cost in these two cases will be as follows:

No. of Trains in a Block.	Cost of Operating Electric Locomotive.	Cost of Operating Steam Locomotive.	Difference in Favor of Steam.	Percentage in Increase of Electricity.
1	$48,000	$25,400	$22,600	90
2	89,500	47,750	42,100	89
3	125,500	67,500	58,000	86⅓
4	145,800	78,750	67,050	85
5	165,800	91,500	74,300	82
6	185,800	103,500	82,300	79
7	205,700	115,500	90 200	77
8	224,300	126,500	97,800	76
9	244,900	139,000	105,900	75
10	265,800	151,000	114,800	75

The above figures indicate that so far as developing power by steam for electrical traction, no economic results would be obtained, but that when power can be delivered at a price less than that estimated as the cost of coal on the steam locomotive, *viz.*, thirty-eight dollars per horse-power per annum, the plan is feasible and would warrant the most careful consideration of those advantages and disadvantages first above mentioned.

The deductions which the writer would draw from the above are the following:

First. That in the present state of the art the application of electricity to steam roads is not a sound, economic proposition when the power is to be developed by steam engines and boilers.

Second. That when power can be delivered to the motor at less than the cost of the coal, extra wages, and repairs of the locomotive, the proposition is sound.

Third. That where water power is readily available, whole roads, or at least one or more divisions, can be operated by electricity to great advantage.

Electrical Furnace in the Manufacture of Glass.

The electric furnace has found a new field of application in the manufacture of glass. The electric furnace is peculiarly fitted for the production of heat in the glass industry, since it introduces no impurities in the shape of combustion products. Molten glass being an electrolyte leads itself readily to electric furnace methods. The first electric furnace for glass-making was designed in Germany in 1882. It consisted essentially of a carbon crucible, open at the base and lined with a net of platinum wire. Into this the raw material was fed, and being fused by the heat dropped through into refining vessels beneath. A later type combines the arc and resistance principle of electric heating. In this the furnace consists of three parts: the upper, an arc for melting the raw materials; the intermediate, the resistance furnace in which a species of refinement takes place which the molten mass completely undergoes before it overflows into the lower receptacle.

In another type, also of German origin, the pulverized raw material is mixed with a binding substance and the mass fed down a chute through rollers and transformed into a continuous sheet or rod, the particles being held together by the binding substance. It next passes over a heated roller which dries it and finally emerges on an inclined plane, forming the hearth or floor of the furnace. Down this it travels at a regular rate depending upon the speed of fusion, and consequent glass formation, the heat for which is supplied by a number of electric arcs traveling down the hearth in a similar manner. —*Cassier's Magazine.*

THE INTERNATIONAL ELECTRICAL CONGRESS.

GENERAL ARRANGEMENT FOR THE RECEPTION AND ENTERTAINMENT OF VISITING ELECTRICAL ENGINEERS.

As the time draws near for the International Electrical Congress at St. Louis, much interest is being manifested both in the United States and abroad. Announcement has already been made of the delegates who have been appointed by the British Institution of Electrical Engineers, and within a very short time the list of foreign delegates will have been completed.

The circular tour arranged by the general reception committee of the American Institute of Electrical Engineers for the reception and entertainment of the visiting foreign delegates, is meeting with approval, and it is estimated that a large party will gather in Boston and New York to participate in this engagement.

The International Electrical Congress will convene at St. Louis, Mo., beginning at 9.30 A. M. Monday, September 12. The opening ceremonies will be held in the music hall of the Coliseum, at Olive and Thirteenth streets. The meetings of the eight sections into which the congress has been divided will follow, commencing at 11 o'clock Monday morning in the section halls on the second floor of the Coliseum. The sections will adjourn on Monday at 1.30 P. M. On Tuesday, Thursday and Friday the sections will meet on the second floor of the Coliseum at 9 A. M., and will adjourn not later than 1 P. M.

The annual convention of the American Institute of Electrical Engineers will be formally opened at Festival Hall, in the grounds of the Louisiana Purchase Exposition, on Wednesday at 10 A. M. Immediately following the annual address by President Bion J. Arnold, there will be a topical discussion between the Institution of Electrical Engineers, of Great Britain, and the American Institute of Electrical Engineers. Arrangements are being made for holding a closing meeting of the international congress. This will probably be held in one of the exposition buildings.

Cooperating with the International Electrical Congress, which is held under the auspices of the Louisiana Purchase Exposition, are the following American organizations: the American Institute of Electrical Engineers, the American Electrochemical Society, the American Physical Society, the National Electric Light Association, the Association of Edison

Illuminating Companies, the International Association of Municipal Electricians, the American Electrotherapeutic Association, and the National Association of Electrical Contractors.

Professor Elihu Thomson is the president of the committee of organization of the congress. The vice-presidents are B. J. Arnold, Professor H. S. Carhart, Professor W. E. Goldsborough, Mr. Charles F. Scott and Dr. S. W. Stratton. Dr. A. E. Kennelly is the general secretary of the congress, and the treasurer is Mr. W. D. Weaver.

In connection with the International Electrical Congress, a chamber of delegates will be held, these delegates being appointed by the various governments. The proceedings will be conducted in a manner essentially similar to the meetings of the chambers of government delegates at the international electrical congresses of Chicago, in 1893, and of Paris, in 1900. A number of the foreign governments have already appointed delegates to represent their respective engineering bodies.

The work of the congress will be divided into eight sections, as follows: A, general theory—Dr. E. L. Nichols, chairman; Professor H. T. Barnes, secretary. B, general applications—Dr. C. P. Steinmetz, chairman; Professor Samuel Sheldon, secretary. C, electrochemistry—Professor H. S. Carhart, chairman; Mr. Carl Hering, secretary. D, electric power transmission—Mr. C. F. Scott, chairman; Dr. Louis Bell, secretary. E, electric light and distribution—Mr. J. W. Lieb, Jr., chairman; Mr. Gano S. Dunn, secretary. F, electric transportation—Dr. Louis Duncan, chairman; Mr. A. H. Armstrong, secretary. G, electric communication—Mr. F. W. Jones, chairman; Mr. B. Gherardi, secretary. H, electrotherapeutics—Dr. W. J. Morton, chairman; Mr. W. J. Jenks, secretary.

Invitations have been extended by the American Institute of Electrical Engineers to the Institution of Electrical Engineers, of Great Britain, to visit the United States in September and to hold a joint meeting in St. Louis in connection with the congress. This invitation has been accepted, and a large number of the British engineers, accompanied by ladies, are expected to arrive in the United States by the White Star steamer Republic, reaching Boston September 2. A general invitation has also been extended to European electrical engineering societies to join in a circular tour, visiting the principal cities and important industrial centres.

A large delegation of the Associazione Elettrotecnica Italiana is expected to arrive in New York August 24 and the subsequent days up to September 2, when they will proceed to Boston, joining the main party there on September 3.

A general reception committee and a committee on transportation and arrangements have been appointed by the president of the American Institute of Electrical Engineers, and local reception committees have been appointed in the cities which are included in the itinerary of the circular tour. The chairman of the general reception committee, with headquarters in New York, is Mr. John W. Lieb, Jr., 55 Duane street. The chairman of the committee on transportation and arrangements is Mr. Ernest H. Mullin, 44 Broad street, New York city.

Arrangements have been made in Boston to receive the visiting members of the Institution of Electrical Engineers at the wharf. The local reception committee in Boston has arranged to take the visiting engineers on a visit to the power-houses in Boston, to the Massachusetts Institute of Technology and to Harvard University, where a reception will be held on Saturday, September 3. After the reception the visitors will leave by train for Providence, where they will take the steamer for New York, arriving Sunday morning, September 4. A rate has been made, inclusive of all expenses in Boston from the wharf, including accommodations at the Vendome Hotel and steamboat to New York city, of thirteen dollars. This sum will cover all expenses from the time the English visitors arrive in Boston on Friday until they reach New York by steamer on Sunday morning.

For the conveniences of foreign visitors arriving at New York on or prior to September 1, and who will proceed to Boston to join the main party, an excursion has been arranged *via* Newport, leaving New York by steamer on the evening of Thursday, September 1, at 5.30 P. M. After spending a day at Newport, those who go on this excursion will proceed to Boston, arriving there at 7.14 P. M. of the same day, in time to join the main party in seeing Boston on Saturday, September 3. A rate has been arranged for this round trip from New York to Boston *via* Newport, and direct return, including hotel expenses in Boston, of $19.25. This covers the return by steamer with the members of the Institution of Electrical Engineers.

While in New York on Sunday afternoon, September 4, the visiting electrical engineers and all the members of the American Institute of Electrical Engineers will be the guests of Messrs. J. G. White & Company on a steamboat excursion either up the Hudson or down to Coney Island, as may be arranged later. On Monday, September 5, the visiting engineers and the members of the American Institute of Electrical Engineers, as guests of the New York reception committee, will make a tour of the electrical power stations of New York city. On the evening of September 5 a reception and dinner will be given by the American Institute of Electrical Engineers to all of the foreign visitors.

The circular tour will be by special train composed of Pullman drawing-room and sleeping cars, and will leave the Grand Central station of the New York Central & Hudson River Railroad at 8.45 A. M. on Tuesday, September 6. This train will run along the east bank of the Hudson river as far as Albany, arriving at Schenectady at 12.45 P. M. The visitors will be entertained at luncheon by the General Electric Company, and will afterwards be shown through the works. On the evening of September 6 high-speed trolley cars will take the visitors to Albany, where dinner will be served at the Ten Eyck Hotel. The special train will leave Albany at 8.30 P. M. over the Adirondack route of the New York Central, and will arrive at Montreal at 7.30 A. M., September 7. The day will be spent in Montreal in visiting local power plants, and a reception will be given in the afternoon at McGill University. Thursday, September 8, will be spent in visits to Niagara Falls and inspection of the power-houses and electrochemical manufactories, and on Friday, September 9, the party will leave Niagara Falls, arriving in Chicago, Saturday, September 10. The party will arrive at St. Louis, September 11, remaining there during the session of the congress until Saturday, September 17. Leaving St. Louis on September 17, it will arrive in Pittsburg on Sunday afternoon, September 18. Leaving Pittsburg on September 19, after visits to the Westinghouse industries, the visitors will arrive in Washington, D. C., at 7.30 A. M., September 20. The train will leave Washington at 8 P. M., arriving the same evening at Philadelphia at 11 o'clock. Wednesday, September 21, will be spent visiting the technical and historical points of interest in that city, and, leaving at 3.30 P. M., the party will arrive in New York at 5.30 P. M.

The cost of a ticket for the American Institute of Electrical Engineers special tour, including railroad fares, sleeping car berth, hotel accommodations (including accommodation at St. Louis), meals and all necessary expenses from New York, following the itinerary above outlined and back, will be $150. This rate, however, does not include hotel expenses in New York city or the expenses of the Boston trip, and does not include admission to the grounds of the Louisiana Purchase Exposition. Those desiring to purchase their tickets for special trips and the circular tour before arrival in the United States, can do so through the secretaries of the electrical engineering societies of which they are members, and from whom they come accredited. The secretaries of these societies can transmit such applications or remittances to Mr. Ralph W. Pope, secretary of the American Institute of Electrical Engineers, 95 Liberty street, New York city.

POLYPHASE SUBSTATIONS.[1]

BY S. L. PEARCE.

INTRODUCTION.

The author does not intend to put forward anything particularly original on this subject, but proposes to deal with the various types of substation equipments that have come chiefly within his own experience, and to consider some practical points that have arisen in connection with their working.

Considerations Determining Equipment—There are several considerations which will determine the particular type of equipment to be employed, and it is desirable briefly to state these: (*a*) traction or lighting requirements; (*b*) frequency of the system; (*c*) two *vs.* three-phase.

The first of these considerations is of great importance, as it will be seen hereafter that some equipments are more suitable for the ever-varying loads and overloads met with in traction work than for the steady lighting loads where a constant pressure is of prime importance.

The second consideration will depend almost entirely on the first. As the frequency of a system has such an important bearing on the capital cost, it is desirable wherever possible that this should be kept high, say from forty to fifty cycles, otherwise the main generators, transformers and motors will become much heavier, and, therefore, more expensive, and at this frequency "mixed" systems can be conveniently operated. The lowest frequency at which arc lighting can be done satisfactorily is about forty-two, and incandescent lighting between thirty and forty. On the other hand, a low frequency of twenty-five is desirable for the operation of rotaries, as the difficulties of commutation and parallel running increase with the frequency.

The third consideration—*viz.*, the question of two-phase *vs.* three-phase—will be decided on for reasons apart from those connected with the substation. The relative cost and efficiency of generating plant and transmission lines for two or three-phase will have to be taken into account. It may fairly be stated that three-phase generators are cheaper to build and lighter than two-phase, while their efficiency is equally good, if not better. The transmission cables are simpler, as also are the switching devices. Theoretically also, at any rate, a greater power can be transmitted in a three-phase system with a given weight of copper than on a two-phase system. As far as the machinery at the substation is concerned, there is little to choose between two and three-phase where efficiencies and cost are concerned, as will be seen from table i, which is taken from Mr. Field's paper on "Systems for Feeding Low-Tension Networks," read before the International Engineering Congress, Glasgow, 1901. Taking these various points into consideration, there is little doubt that three-phase is to be preferred, as it is no more complicated than two-phase, has advantages in prime cost, gives a better over-all efficiency, and has been adopted in the majority of installations in England. The author is aware, however, that there are one or two successful two-phase plants at work. In these cases two-phase has probably been adopted owing to a system of single-phase mains having previously existed. The change from single-phase to two-phase can be readily made, as has been done in the case of the Metropolitan Company, where two-phase motor-generators are used for that part of its system requiring direct current. The equipment to be considered in this paper will be of the three-phase type, with terminal voltages of from 5,000 to 10,000.

CONVERTING EQUIPMENT.

(*a*) Rotary Converters—The voltage on the alternating-current side between slip-rings is a definite percentage of the direct-current voltage, being approximately sixty-one per cent for three-phase working with three slip-rings, seventy per cent for two-phase with four slip-rings, thirty-five per cent for six-phase working with six slip-rings, and fifty per cent for four-phase with four slip-rings. These values are dependent on the pole-width.

The outstanding advantages to be obtained from the use of this class of converter are low prime cost, high efficiency, ability to stand overload limited only by the temperature rise, small floor space for a given output, and the high power-factor which can be maintained over the system. On the other hand, there is a certain want of stability which manifests itself in sensitiveness to variations in the line voltage, causing difficulty in parallel running, and a tendency to hunt and get out of step. This want of stability is more noticeable in rotaries built with laminated-steel poles than in those with solid pole-pieces. The regulation also is not as flexible as in other systems, and switch gear and switching operations become somewhat complicated, but for purely traction schemes, their high efficiency and ability to stand very considerable overloads, are factors of great importance which more than outweigh the disadvantages named. Although the six-phase connection for rotaries is complicated, there is a considerable economy to be gained in the use of it—a fact which is being recognized in the latest installations in England. Owing to the distributed nature of the tappings on the alternating-current side, the heating of the armature is more uniform, and there is, consequently, a considerable gain in the output, since this depends on the temperature rise.

The step-down transformers may be connected up either "star" or "mesh." The advantage of the latter method lies in the fact that should one transformer be put out of circuit through any cause, the supply will not be interrupted; the remaining transformers will still maintain a three-phase supply to the converter, which can be run at its full load as long as the heating in the two remaining transformers does not become excessive. "Star" connected transformers are cheaper in first cost, since the pressure between the centre point of the star and the end of either transformer is proportionally less than the line voltage. For lighting schemes with distribution on the three-wire or three-phase system, there is a distinct advantage to be gained by the "star" connection, since the centre point can be

TABLE I.

Type of Substation.	Cost.	Efficiency of Equipment.			Total Weight. Tons.
		Full Load.	¾-Load.	½-Load.	
Three-phase rotary with transformers	A £2,160	91.0	89.75	86.75	33
	B 2,560	92.0	90.5	888.0	31
Two-phase ditto	A 2,240	91.0	89.75	86.75	34
	B 2,580	92.0	90.5	88.0	36
Three-phase synchronous motor-generator	A 2,400	89.5	88.25	85.35	43
	B 2,280	86.5	85.0	81.5	44
Two-phase ditto	A 2,400	89.5	88.25	85.25	45
	B 2,280	86.5	85.0	81.5	44
Three-phase induction motor-generator	A 2,680	89.0	87.75	84.75	50
	B 2,260	85.5	84.5	81.5	44
Two-phase ditto	A 2,690	89.0	87.75	84.75	50
	B 2,300	85.0	84.0	81.0	45

N.B.—A and B refer to different makers.
All the above refer to 500-kilowatt converter equipment, operating at 25 cycles and 6,500 volts.

[1] Paper read before the Incorporated Municipal Electrical Association. June 30. Slightly abridged. Illustrations reprinted from *Electrician* (London).

connected to the middle or neutral conductor for balancing purposes.

It has been pointed out previously that rotaries should be operated at low frequencies of twenty-five to thirty cycles per second to attain the best results. This guarantees the more stable operation of the machines, and permits a wider range of compounding than is obtainable with higher frequencies. The author believes that the tendency in the future will be toward standardizing periodicities of twenty-five and fifty, as the latter, being an exact multiple of the former, enables the prime movers to be built on exactly similar lines, the only difference being in the number of poles. Where rotaries are being operated at forty to fifty cycles, it would appear desirable to have connected on the same system a proportion of induction motors, which would tend to act as "electric dashpots" in the system, and thus help to make the rotary converters more stable than they would be in a system having nothing but rotaries.

(*b*) Synchronous Motor-Generators—This type of equipment consists of a synchronous motor driving one or more generators, the whole constituting one complete and self-contained set. No intermediate transformers are necessary, as the line pressure is brought straight on to the terminals of the stator of the motor. It is usual to build the motors of the revolving-field type, with the exciting current led up through slip-rings to the field coils, either from an independent exciter mounted on to the end of the shaft from the generator terminals, from the low-tension lighting bus-bars or other means to be described later. The merits of this system, in which higher frequencies can be employed, are simplicity of operation, flexibility, high power-factor in working and the fact that the regulation of one direct-current side pressure is independent of the alternating-current voltage. As compared with rotaries, they are some three to four per cent less efficient, and their ability to stand overloads is determined by the overload capacity of the generator. For lighting and "mixed" systems, the synchronous motor-generator has much to commend it on the ground of stability, satisfactory parallel running and ease of regulation.

(*c*) Non-Synchronous Motor-Generators—The high-pressure currents in this case also are led either through choking coils or direct to the motor, and the starting up is accomplished from the high-tension side. Consequently, no complicated switch gear is required, and synchronizing is obviated. As with synchronous equipments, the regulation on the direct-current side is independent of the alternating current. The great drawback to non-synchronous motors is the comparatively low power-factor at which they work. For mechanical reasons, the width of the air-gap in induction motors is considerable, more particularly with small units, and it is advisable to watch this closely with a view to keeping it equal at top and bottom of the rotors. In order to avoid heavy lagging currents on the system, the motors should be run well up to their full load. Lagging currents not only waste energy, but pressure regulation becomes exceedingly difficult owing to their demagnetizing effects. It is for these reasons that the use of small non-synchronous motor-generators alone is not to be recommended, but a combination of the types (*b*) and (*c*) can be used with good results. In every substation means must be provided for starting up from the alternating-current side in the event of low-tension direct-current not being available. For this purpose the motor-generator with an induction motor is specially useful owing to the rapidity with which it can be started to enable a supply of direct current to be obtained for starting up the synchronous sets. If the latter be run with their fields "stiffened" or slightly over-excited, the heavy lagging currents of the induction motor may in some measure be compensated for, and the power-factor of the system thereby improved.

A modification of the ordinary induction motor-generator has recently been brought forward by one firm in England under the name of "motor-converter." This combination consists of a direct-current generator coupled to an induction motor—the two machines being electrically as well as mechanically interconnected. High-tension currents at fifty periods circulate in the stator windings of the induction motor. Owing to the back electromotive force of the direct-current machine the speed of the rotor, however, corresponds to half synchronism only. Currents are, therefore, generated in the rotor windings at a periodicity of twenty-five, and these currents pass into the direct-current armature by suitable cross-connections, and are there commutated. Theoretically, half the power of the combination is transmitted through the shaft, and the remaining half through the electrical cross-connections. In the first case the direct-current machine acts as a generator; in the latter case the motor acts as a transformer, and the direct-current machine as a generator. To a certain extent, therefore, this machine appears to combine the advantages possessed by both motor-generators and rotary converters, and the practical results obtained therefrom will be of considerable interest.

Table ii shows the relative cost, efficiency, floor space, and power-factor of various sizes of the three classes of equipment.

Fig. 1 comprises three curves showing the approximate relative cost of three types of substation equipment.

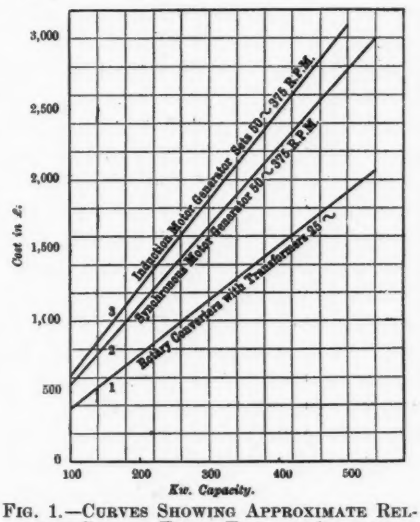


FIG. 1.—CURVES SHOWING APPROXIMATE RELATIVE COST OF THREE TYPES OF SUBSTATION EQUIPMENT.

(*d*) Static Transformers—The distribution of polyphase currents at low pressure is undoubtedly coming to the front. There are already in England instances of new and successful public lighting schemes on this system, and a considerable demand is springing up in various towns for a supply of three-phase current to large works, more particularly in engineering and shipbuilding districts. A substation of this type has recently

TABLE II.

VOLTAGE 6,500. FREQUENCY 50.

	Asynchronous Motor-Generators.	Synchronous Motor-Generators.	Rotaries (not including transformers).
Output	220 kw.	220 kw.	220 kw.
Costs	£6.1 per kw.	£5.5 per kw.	£3.8 per kw.
Efficiency (full load)	86%	89%	92%
Floor space	12′ 3″ approx. × 8′ 5″	12′ 3″ approx. × 8′ 5″	7′ approx. × 7′
Power-factor (full load)	92%	Unity.	Unity.

been put down in Manchester for the supply of three-phase current at 200 volts to some extensive locomotive works, where it is expected that the ultimate demand will be approximately 700 kilowatts. It seems reasonable to suppose that the present recognized systems of converting alternating current to direct current will in time be superseded by one embodying direct transformation from high to low pressure. When one considers the increased capital involved in respect to plant and buildings for substations equipped with rotaries or motor-generators, the increased labor costs for running and maintenance and the moderate all-day efficiencies obtained, it would appear that the polyphase system of distribution for mixed "lighting and power schemes" has much to recommend it. The three-phase motor is proving eminently satisfactory where speed regulations is not a prime essential, and the difficulties even in this respect are not insuperable.

The transformation of polyphase currents can be, and more frequently is, carried out by the use of three single-phase transformers, which may be connected up either "mesh" or "star" fashion. The advantage of using three-phase transformers is a saving in copper and iron, resulting in a lower first cost; further, their common magnetic circuit tends to reduce any variation in the pressure between the phases, and for this reason they are preferable for use on lighting circuits. The great advantage in using the single transformer type is that breakdown risks are minimized and a smaller amount of spare plant is required. These points largely counterbalance the advantages attendant on the use of three-phase transformers. Transformer units should be few in number and of as large an output as possible, since, although any gain in efficiency by the employment of large units may be inappreciable, simplicity in the arrangement of the substation and the reduction of the switch gear required to a minimum are important factors.

Either oil-cooled or forced-draught ventilation transformers will give good results, particularly if in the former proper means are taken with the larger units for securing the cooling of the oil by circulating cold water through it or *vice versa*. The second method has been more generally used in the author's experience. This type of transformer, constructed with subdivided coils, not only keeps the transformer cool by allowing the forced air to circulate, but renders it more easy to insulate for voltages up to 10,000 with perfect safety. Forced draught cooling involves the use of a blower, which is usually driven by a small induction motor operating at low pressure. Such types of transformers are capable of giving very large outputs for their weights and high efficiencies. There is always the risk of breakdown of the induction motor to be reckoned with, a state of affairs which usually ends in the particular bank of transformers being put speedily out of commission.

The transformer with natural draught ventilation has much to commend it, as without a doubt air blasts, oil or any other cooling devices are somewhat open to objection. Given large radiating surfaces inside and out, combined with ample ventilating spaces through which currents of fresh air can continuously pass, this type should give as good results as either of the former.

The following table gives the comparative cost for the various types of a 250-kilowatt equipment working at 5,500 volts and fifty periods:

	Three-Phase Transformers.	Three Single-Phase Transformers.
	£ per kw.	£ per kw.
1 Oil cooled.....	0.8	1.4
2 Cooled by air blast....	0.78	1.17
3 Natural cooled.....	0.9	1.5

SWITCH GEAR.

Position of Boards—It will be found convenient to place the high and low-tension boards on different galleries, either opposite to or at right angles to each other, but on the same level, with easy means of communication between the two. This arrangement, besides having the advantage of separating the high-tension and low-tension gear, will facilitate the wiring up of the station and avoid any dangerous crossings of the cables.

Type of High-Tension Board—Much has been written on this somewhat thorny subject, and the matter is still to a great extent *sub judice*. Three distinct types, however, have come within the author's experience, *viz.*, the flat board, the multi-frame, and the cellular or compartment board. The former with its exposed switches, fuses and wiring, etc., mounted sometimes dangerously low down, and small space provided at the back, is quite unsuitable for high pressures, and is rarely seen now in the later high-tension substations. Several modifications of this type, however, are in use, such modifications consisting in the raising of the height of the high-tension bus-bars and partially covering them in, live fittings of any description being exposed only at the back and top, the front being absolutely free from any high-tension wo and instruments mounted at the fro being worked off transformers. Exam ples of high-tension switchboards o these lines have been installed at the Ce tral London substations, and are doing good service.

The "multi-frame" type of board ma be said to represent very largely the Co tinental practice, and consists of pra tically two or more distinct framework the first carrying the marble front on which are mounted the switch ha dles and instruments worked off tran formers. The second framework may b behind or above the former, th forming a second gallery. This la ter carries all the high-tension wor Ample passage-ways are provided a round, and, in addition, all high-tensi parts are enclosed in caging of iron mes ing with suitable doors which can b locked as required. This type has th disadvantage of taking up considerab floor space, but the possibility of attend ants getting round to the high-tensi portions at the back is not great, and th boards are readily accessible for cleani and repairs when required. Next to safe should come efficiency and reliability, a on these points the multi-frame boa gives excellent results.

The "cellular and backless" type o board in one of its particular forms i well known in England, and has be most extensively used in single-phase sy tems. Its adaptation for two and thre phase working will be watched with co siderable interest, especially as in so schemes it has come into direct compar son with the multi-frame type. Th whole arrangement of this type of boa is too severely compact for the high pressures and powers, and repairs are n easily effected when required, but the sa ing in floor space is considerable, which a consideration when substation sites a restricted in this respect.

Other types are generally modification combinations or extensions in some for or other of those named. In some cas the switch gear is subdivided into se tions, occupying different galleries, forming groups on the same gallery. I other cases all the high-tension gear remote controlled, operated by hand di rect or auxiliary relay apparatus, eithe electrical or pneumatic.

Arrangement of Bus-Bars—The ar rangement of the bus-bars is the firs question to decide when the type of boa has been settled. Simplicity as far as

is compatible with reliability of supply is essential. With a mixed system the author considers that this is fairly obtained by using one set of bus-bars for lighting and another set for traction, every feeder and every machine being provided with "change-over" or "selector" switches, so that they can be connected up to either set of bus-bars. In effect a set of duplicate bus-bars is thereby provided. Means can also be provided, if desired, for coupling together the two sets of bars in the substation, but where it is the rigid practice to keep the traction and lighting bus-bars separate, it may be desirable that coupling switches should be provided at the generating station only. In the case of a lighting system only, it is still advisable as a stand-by and as a means of isolating any generator on to any feeder, that a duplicate set of bus-bars should be provided. The use of a second bus-bar has always been found invaluable in the testing of any faulty feeder or machine, as it permits of this being done during the hours of ordinary supply. Such an arrangement of duplicate bars is, in the author's opinion, preferable to the so-called ring systems with disconnecting links. For these reasons the extra capital cost involved will be well repaid by the increased reliability and efficiency of working.

The question of "fusing" or not fusing is one that is still much debated. If fuses be decided on, then two conditions may be laid down as essential: (1) they must open circuit cleanly and without enabling a rise in potential to take place. (2) They should be situated on a gallery or in a basement alone; in short, they should be severely isolated from the rest of the high-tension gear, where, in the event of failure of action, the damage is confined to a comparatively small area. They should also be in duplicate.

It may safely be stated that excessive rises in pressure on interrupting the circuit are not experienced with oil-break fuses, but whether this or the ordinary type be adopted, the employment of spark-gaps in addition on the system is to be recommended, as the additional expense is trifling. Some one has truly said that fuses are very good things to do without, and from the author's recent experience he is inclined to the conclusion that fuses are not to be relied on in extra high-pressure work, and that the substitution of an "overload" oil-break automatic switch with time limit and mechanical or electrical control attachment will give the best results. Such an arrangement should be fitted to each high-tension machine in the substation, the high-tension feeder ends being connected straight on to the bus-bars, and controlled by automatic oil circuit-breakers of the overload type at the power-house end only. In some cases reverse-current circuit-breakers have been fitted on the feeders at the substation ends to ensure continuity of supply in the event of a short-circuit occurring on any one feeder.

For the protection of high-tension overload circuit-breakers, in the event of a feeder breaking down and to ensure their reliable working, the arrangement shown in Fig. 2 has been adopted in one or two systems in America, and is to be used on the Metropolitan District Railway, London. Between the centre point of the star-winding of the main generator or the substation converters and the earth-bar a resistance is inserted which will only carry four times the full-load current of the machine. As three-core feeder cables rarely break down between cores, but generally to earth, the amount of current passing can only with this arrangement

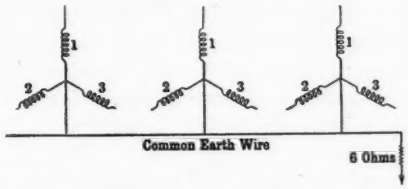


FIG. 2.—PROTECTING HIGH-TENSION OVERHEAD CIRCUIT-BREAKER.

equal four times the full-load current of the generator.

Synchronizing—The tendency appears nowadays to be in the direction of synchronizing at the line voltage. There appears to be little to recommend this, and it certainly is desirable on the grounds of safety to work off low-tension synchronizing bus-bars.

Cable-Charging Gear—The question of the advisability of providing cable-charging apparatus is another moot point. The author believes that in the majority of cases there is probably no need for this provision, and he would instance the Central London and Glasgow equipments with high-tension feeders some four to five miles in length. The American practice is decidedly opposed to the instalment of this apparatus, and there is hardly a power station in the States to be found so equipped. It would be out of place somewhat to consider the pros and cons of the question in this paper, or of the various types used—*viz.*, (1) separate motor-generator forming the cable charger; (2) water resistance; (3) the "Partridge" arrangement, involving the employment of a three-phase transformer, the primaries being connected in series with the three-core cables, and the secondaries connected up to a non-inductive resistance.

High-tension switch gear appears to be passing through a transition stage, designs seem to be changing almost every year, and nothing can be called standardized in this direction. Probably the design of the future will be one that combines the cellular or compartmental arrangement with remote control.

EXAMPLES OF ROTARY EQUIPMENT.

In a typical rotary substation in connection with the electrical equipment of the North-Eastern Railway, the size of rotaries employed is 800 kilowatts with three-phase connections. All the high-tension gear is placed down one side of the station, and the low-tension gear on the opposite side, with the rotaries and their accompanying transformers between. The incoming high-pressure feeders are fitted with spark-gaps, provision being made by means of isolating switches to allow of their inspection while the feeder is alive. The feeder switches are of the oil type, capable of breaking the maximum current of the station, and electrically operated from the low-tension board. In connection with these switches are reverse-current relays, which automatically open the switch should the current reverse. The main high-tension bus-bars are placed on the top gallery and enclosed in fireproof cubicles—the main switches being situated on the intermediate gallery—the fireproof wall supporting the high-tension gear being built of cement blocks, with partitions between each phase and each circuit. Electrically operated switches are placed in the circuit between the high-tension bus-bars and the primaries of the transformers, fitted with time-limit overload cutouts, the secondaries being connected straight on to the three slip-rings of rotaries. Provision is made for all high-tension circuit-breakers to be inspected and cleaned with safety by means of isolating switches.

The main transformers are of 280 kilowatts each, with a voltage ratio of 5,500/-360 working at a frequency of forty. They are oil-insulated, of the self-cooling type, and are connected up in "delta." The rotaries are started up by means of induction motors mounted on an extension of the armature shaft, separate step-down transformers being provided for the supply to these motors. The machines have an efficiency of 93.44 at three-quarters

load to 93.94 at one and one-half times full load.

The low-tension switchboard, besides containing the ordinary panels for operating the direct-current side of the rotaries, comprises the panels for the operation of the oil switches on the high-tension feeders and transformers.

In another typical arrangement for a large capacity rotary substation, the main high-tension bus-bars are placed below ground floor, single three-phase transformers are employed, and the cooling of the latter is effected by means of a separately driven blower set. Reactance coils are used in conjunction with the rotaries for traction purposes to obtain the compounding effect; these reactance coils would be replaced by induction regulators (which enable the impressed electromotive force on the rotary slip-rings, and, consequently, the direct-current voltage, to be varied at will), if the machines were used for lighting purposes. The low-tension switch gear is similar in all respects to that of an ordinary direct-current station. In the case of a purely traction system the switchboard proper would only contain one pole, the remaining switches and bus-bars being placed in the vicinity of the machines themselves in the same way that equalizer switches and bars are now placed in many large direct-current traction stations.

The negative pole of the rotary being directly connected to the negative bar and earth without introducing any switch, the secondary of the transformer is permanently earthed through the machine, and forms a safeguard in case the high-tension winding of the transformer should break down on the secondary. This arrangement very much simplifies the switch gear, as the equalizer switch is mounted on the rotary itself, the equalizer bar and negative bar being placed in a pit close below the rotaries, leaving only the positive single-pole switch and bus-bar to be placed behind the switchboard proper.

It is preferable that the high-tension transformers in substations of this type should be placed in the same room as the rotary converters themselves. The great advantage of having them continually under observation, in the author's opinion, outweighs the argument that the safest position for the high-tension apparatus of this nature is under lock and key. It is quite possible for a serious fire to start without the fact being known when the transformers are contained in a separate compartment, whereas, when they are readily seen, they can be cut off from the line on the slightest indication of a fault.

(To be concluded.)

Recent British Electrical Inventions.

The following are abridged descriptions of British patents specially compiled for the ELECTRICAL REVIEW by Messrs. Hughes & Young, registered patent agents and engineers of 23 Coleman Street, London, E. C., of whom our readers may obtain all information and advice relating to British and foreign patents, designs and trade-marks free of charge.

4,836.—March 2, 1903. Patentees, Messrs. Siemens & Company, 12 Queen Anne's Gate, Westminster, England.

To increase the strength of a long commutator and to provide for effective cooling of the segments, the commutator is made up of two or more separate spaces

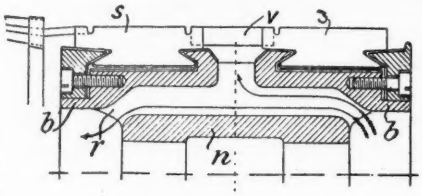


FIG. 1.—COMMUTATOR.

between them as shown in Fig. 1. The segments s of one commutator are connected to those of the contiguous one by thin strips on conducting material V, which forms a grid through which the air can pass. The body b is supported on the hub n by ribs r, the spaces between which form ventilating channels in connection with the air spaces between the contiguous commutators.

5,150.—March 5, 1903. Patentee, R. W. Saunders, 14 Southerton Road, Hammersmith.

A method of preventing undue sparking at the interrupter of an induction or

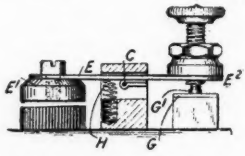


FIG. 2.—SPARKING COIL.

sparking coil is shown by Fig 2. The contact G′ with which the contact E^2 of the vibrating armature lever E pivoted at C, cooperates to make and break the induction coil circuit is carried by a flat spring G, which causes the contact G′ to follow the contact E^2 on the "break" stroke and so retard the break until contact E^2 is moving rapidly. The contacts E^2, G′ are normally forced together, and the spring G strained by a spring H′. The contact E^2 may be adjustable and the spring G placed under it as shown, or the spring may be adjustable and placed over the spring lever E between its pivot and the armature E′.

5,183.—March 5, 1903. Patentee, M. Kotyra, 26 Avenue des Ternes, Paris.

Telegraphs. A keyboard transmitter for the Morse or other code consists of a number of keys d', each for one letter or sign, and each connected with means

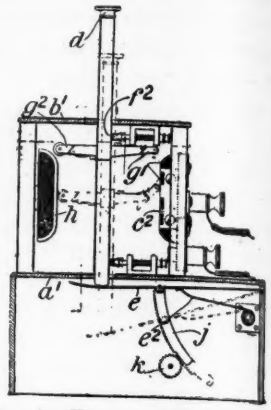


FIG. 3.—KEYBOARD TRANSMITTER.

for producing the corresponding succession of currents in the line. In the construction shown in Fig. 3 each key is a vertical strip sliding vertically in slots in stationary plates b', a', and normally held up by a lever e and a spring e^2. Each strip has arms carrying pivoted pieces g', g^2 and rollers, these being normally held straight out by springs; the piece g' can turn upward, and the piece g^2 downward only. When a key is pressed down, the roller in the pivoted piece g' bears against a stationary insulated cam h, and the key is thus moved forward in the slotted plates b', a', in opposition to spring pressed rollers f^2. The roller in the pivoted piece g' is caused to pass along stationary metal contacts c^2, through which current is thus passed to line. The rate of signaling is limited by a toothed sector j on the lever e engaging and turning a long pinion k and an air fan. When the key

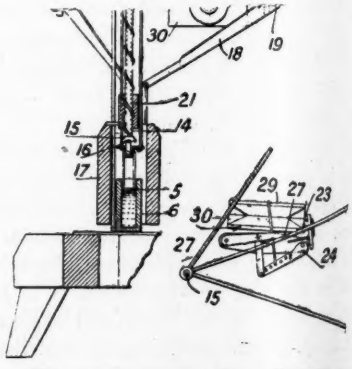


FIG. 4.—AUTOMATIC GATE OPENER.

is allowed to rise, the pivoted piece g' turns down in passing the cam h, and the roller in the front piece g' rises clear of the contacts c^2.

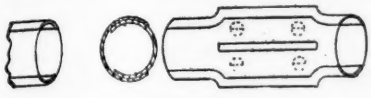
5,204.—March 5. Patentee, T. Vickers, 29 Woodborough Road, Nottingham.

To automatically operate the brakes

when a safety fender is brought into use the gate 23 or other part of the safety fender of an electric tram car is moved by contact with an obstruction, the arm 26 is released from a catch 28 and allows a spring 27 to reverse a switch 12, which applies the electric brakes. The switch is interposed between the ordinary hand-operated controller 6 and the motor 13, and, when in the position shown in Fig. 4, allows the controller to be manipulated, either to supply current for the motor or to apply the electric brakes 17 through the ordinary connections. When the switch 12 is reversed, current flows from the motor, acting as a generator to the electric brakes, and may also flow through a pull-out 20, which operates the switch 21 to disconnect the controller from the trolley wire 1.

5,240.—March 6. Patentee, R. H. W. Knight, 108 Ardgowan Road, Catford.

Conduits are formed of strips of sheet steel, hard bronze, brass, fibre compound,



FIGS. 5 AND 6.—CONDUIT AND TUBULAR FUSE BOX.

etc., bent so as to form a trough a little more than a semicircle in section. One such piece is secured to the wall, etc., and, after the conductors are inserted, a second similar one is sprung over it, as shown in Fig. 5, to form a complete tube. T-pieces, crosses, bents, etc., are similarly formed. Fig. 6 shows a tubular fuse box similarly formed. The tubes may be insulated by placing them in a slightly heated condition into a bath of paint, enamel, pitch, bitumen or rosin, and then allowing them to cool.

Naval Control of Wireless Telegraphy.

President Roosevelt approved on August 1 the report of the board appointed some time ago to consider wireless telegraphy in the United States, in its relation to the army, navy and general government use. Rear-Admiral Robley D. Evans, chief of the lighthouse board; Brigadier-General A. W. Greeley, chief signal officer of the army, and Professor Willis Moore, chief of the weather bureau, with a representative of the department of commerce and labor, composed the board. By the report of this board, control of coastwise wireless telegraph stations is given to the navy, and control of whatever stations are necessary to communicate with the various army posts is given to the army. This arrangement, however, must not interfere with the coastwise stations. The army is to have control of the wireless stations in Alaska and on the frontier. The board also recommends legislation by congress to prevent interference in any way by private stations with navy control of the coastwise stations.

Artificial Loads for the Dissipation of Electric Power.

Discussing artificial loads, H. C. Davies writes in substance as follows:

An artificial load is an obvious necessity with the comparatively large sets in use at the present day, due regard to liability and freedom from risk necessitating the trial running of the set at something approaching full load for a short time after a repair of anything but a trifling nature has been performed. This is especially the case in alternating works, owing to synchronizing difficulties. In a surprisingly large number of works tubs are used as artificial loads, but they are both impracticable and expensive and in alternating and direct-current works of any size it will be found to pay to install properly designed permanent water loads, the apparatus being simple and inexpensive. The passage of a current through water produces heat, as the boiling point is approached the resistance decreases markedly. For convenient working the water must be constantly renewed in order to maintain its temperature. The nature and supply of the water must also be considered as the resistance is apt to vary greatly. While the water load is undoubtedly the best and handiest medium for testing, there are other types in use which may be recommended for purposes apart from machine testing. The carbon rheostat was one of the first power absorbers and has done excellent service. The best form is made up of a series of carbon plates in a frame fitted with a screw for tightening up or slackening back, the contact between the plates being increased or diminished and the resistance of the whole varied in proportion. In this form the resistance is due not so much to that of the carbon itself, as to the more or less bad contact between the plates. Cooling is the chief difficulty presented by this apparatus and for this reason it is more suitable for small powers than for large. A handy, inexpensive form of artificial load may be made up of galvanized iron netting wound in a spiral, using non-inflammable insulating distance pieces or by folding backward and forward over an iron frame built up on insulators. This is valuable for testing small machines such as excitors. Iron netting, especially that having a right-angled mesh, is an excellent dissipator of heat, one set of wires carrying current, while the other at right angles conducting away much of the heat. Expanded metal also makes an effective resistance and in many ways is preferable to netting, being stronger and requiring less supports.—*Electrical Engineer (London), July.*

Electricity as a Cause of Fires.

The electrical bureau of the National Board of Fire Underwriters reports on the number of fires caused by electricity. For the three months from April 11 to July 11, there were 145 fires with losses aggregating over $172,000. Thirty-three fires especially mentioned in the report were due chiefly to grounding, short-circuiting, destroyed insulations and defective wiring. Twenty crosses of telephone, telegraph and other signaling circuits with lighting and power circuits were reported. Twelve fires were caused by dynamos and motors, in eight cases due to burning out of armature or field coils. Twenty-seven cases of grounding of circuits are reported, twelve of which were on awnings and metal work of buildings. Five fires were caused by short-circuiting in flexible cord, due chiefly to the use of defective commercial cord with poor insulation, and to the wrapping of the cord round pipes, nails, etc. Six fires were reported due to short-circuit of wires in fixtures, four by short-circuit in watt-meters, one of them being the old-style chemical device. Four fires were due to the use of open link fuses in defective porcelain cut-out blocks. Five fires were caused by the heat of incandescent lamps located near inflammable material. Twelve reports of damage by lightning were recorded. In a number of these the lightning entered the building over the lighting or signal wires which were not properly protected.

Delegates of the British Institution of Electrical Engineers.

The British Institution of Electrical Engineers has elected the following gentlemen to attend the International Electrical Congress to be held at St. Louis on September 12 to September 17. Mr. R. Kaye Gray, president; Colonel R. E. Crompton, C. B., past-president; Professor John Perry, F. R. S., past-president; Dr. R. T. Glazebrook, F. R. S., member of council; and Mr. H. E. Harrison, B. S., B. A. Mr. W. Duddell will act as secretary to the delegation.

First Message from Nome, Alaska.

General Greely, chief signal officer of the United States army, received at Seattle, Wash., August 9, the first telegraphic message ever sent direct from Nome, Alaska. It marks the inauguration of the government wireless system from Nome, 107 miles to St. Michaels. From St. Michaels the message came by the wire line up the Yukon to Dawson, and thence to Seattle, traveling 3,500 miles altogether.

The Association of Edison Illuminating Companies.

The twenty-fifth convention of the Association of Edison Illuminating Companies will be held at the Hotel Wentworth, New Castle, N. H., commencing Tuesday, August 30, 1904, at 9.30 A. M. A most successful convention is anticipated, and the member companies are requested to send as many representatives as possible.

The following list of papers has been announced, and the subjects to be given consideration are important.

"A Plea for Uniformity in Construction and Operation of High-Tension Systems," Philip Torchio.

"Notes on Economy in the Production of Steam," W. F. Wells.

"Experiences with Automobile Charging Stations," Joseph W. Cowles.

"Vulnerable Points in Operation of High-Pressure Alternating Transmission, Supplying Large Distributing Systems," D. L. Huntington.

"The Relative Efficiency of Electric and Hydraulic Elevators," W. C. L. Eglin.

"Electric Heating and Cooking," H. W. Hillman.

"Relations between Length of Arc, Voltage and Candle-Power in Enclosed Arc Lamps; and the Effect upon Efficiency of Arc Lamps by Varying Size of Carbons," George N. Eastman.

"Gas Engines *vs.* Electric Motors," Frederick M. Kimball.

"Light and Illuminating Engineering," W. D'A. Ryan.

"To What Extent Should Central Stations Make Investments?" John F. Gilchrist.

"Results Up to Date Obtained from the Use of the Wright Demand System of Charging," John W. Ferguson.

"Results Up to Date Obtained from the Use of the Wright Demand System of Charging," Arthur S. Knight.

"Some Commercial Problems," Joseph D. Israel.

"Notes on European Testing Laboratories," Dr. Clayton H. Sharp.

"Measuring Instruments in Generating and Substations," Caryl D. Haskins.

"Troubles and Losses between Generators and Customer's Services," P. Junkersfeld.

"Some Data on Electric Power," Arthur Williams.

The Hotel Wentworth is reached *via* Boston, thence by Boston & Maine Railroad to Portsmouth, N. H. Conveyances will meet the train and transport the guests to the hotel.

The announcement of this meeting, which is made by Mr. Wilson S. Howell, assistant secretary, Eightieth street and East End avenue, New York city, suggests that the delegates be accompanied by the ladies of their families. There will be many features of interest and entertainment which they will appreciate and enjoy. A golf tournament has been arranged, and prizes have been offered.

The International Railway Congress.

The seventh convention of the International Railway Congress will be held at Washington, D. C., May, 1905. From April 27 to May 2 the delegates are expected to arrive, and on Wednesday, May 3, the registration bureau at Washington will be opened. On Thursday, May 4, the formal opening session will take place. From May 5 until May 13 there will be formal meetings of the sections of the congress. On May 15 the various sections will depart on tours of inspection. Approximately, there are 183,946 miles of railways represented by the members of this congress.

The work of the congress will be divided into various sections. Section 1 will take up ways and works; section 2, locomotives and rolling stock; section 3, working; section 4, general; section 5, light railways.

The International Railway Congress is a permanent organization established to promote the progress and development of railways. The "adherents" of the congress are railway administrations and governments. Its affairs are regulated by a permanent international commission composed of the ex-presidents of the sessions of the congress, who are members *ex officio,* and thirty-three elective members, of which one-third retires at each session of the congress.

The present officers are: president, A. Dubois; general secretary, Louis Weissenbruch; treasurer, Edouard Holemans.

Trolley Dining-Car.

A trolley dining-car is to be established by the Aurora, Elgin & Chicago Railway Company. While it is stated that this trolley will be at first available only for special parties, the dining-car will eventually be placed in general service, making four runs daily between Chicago and the Aurora and Elgin terminals. The car was built at an expense of $12,000, and is named the "Carolyn." Twenty-eight persons can be accommodated.

Liquid Fuel in Its Application to Electricity Works.

In times of sudden and great demand for steam, the methods of coal firing being admittedly so unsatisfactory and wasteful, writes Francis H. Davies, it seems strange that no effort has been made to reduce this inefficiency by the use of oil fuel. This would have the double advantage of securing greater reliability and reducing cost. At the present time petroleum fluctuates too greatly in price to warrant its exclusive use as a fuel, but as an adjunct to coal-fired boilers under conditions of stress, it would be very valuable. The effect of fresh fuel in a furnace, howsoever fed, is always a damping of the fire when the contrary is most desired, and the frequent result is that by the time the extra steam is ready the demand for it is gone. With oil, on the other hand, there is no rush or smoke, no extra labor and a great increase in the steam. Less equipment is required, so many stand-by boilers not being needed, and the combustion of extra fuel is stopped immediately that the demand ceases. Ideal conditions for the burning of oil are more easily obtained than for coal. It may be burned in any furnace, but gives highest efficiency in one lined with refractory substances as the full vaporization of the oil is got. The amount of air required with petroleum is fifteen times the weight of the combustible. Its steam-raising capacity is twice that of the average coal. The present method of burning petroleum is by spraying it into the furnace in an atomized state, some authorities preferring steam as an atomizing agent, and others air. Which ever is used should be thoroughly dry.—*Electrical Magazine (London).*

The American Electrochemical Society.

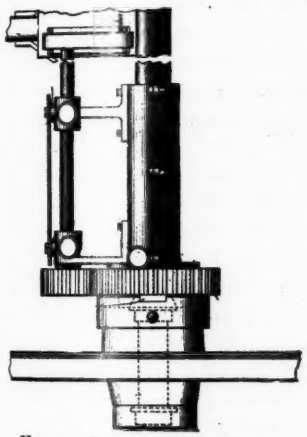
The St. Louis meeting of the American Electrochemical Society will be held on September 13, 15 and 16. On September 13 and 15 a joint meeting will be held with section C of the International Electrical Congress. On September 16 a joint meeting will be held with the Bunsen and Faraday societies. The meetings will be held at the Coliseum, Olive street, between Thirteenth and Fourteenth streets, St. Louis, Mo.

American Society of Municipal Improvements.

The annual meeting of the American Society of Municipal Improvements will be held at St. Louis, Mo., October 4 to 6, inclusive. The programme has not yet been issued. The office of the secretary of the society, Mr. George W. Tillson, is in the Municipal Building, Brooklyn, N. Y.

Electrical Patents.

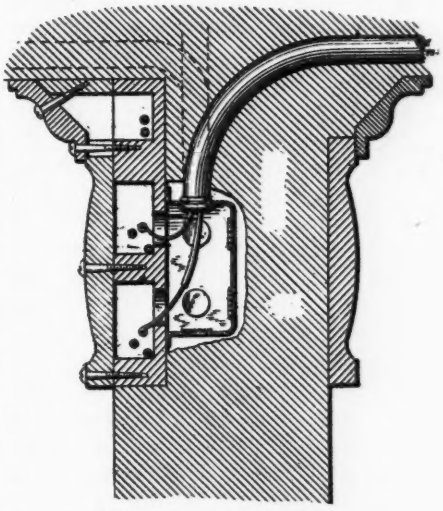
John A. Little, of St. Louis, Mo., has assigned to the Globe Electric Company, St. Louis, Mo., a patent recently obtained by him on an improved vehicle lighting apparatus. In the embodiment of the invention, a sleeve made in two parts and fastened together by screws is firmly clamped upon the axle. The outer end of the sleeve is enlarged to form a flange and journal. Upon this journal a gear-wheel is adapted to rotate. An oil-cup is provided for lubricating the bearing. A collar is fastened upon the hub of the vehicle wheel and held in place by means of a set-screw. This collar is provided at one side with a groove which fits over the inner end of the hub, and has at its opposite side two notches or keyways into which corresponding keys carried by the side of the gear-wheel are adapted to enter. Brackets are fastened to one side of the sleeve or casing and carry journals in which the shaft is adapted to rotate.



VEHICLE LIGHTING APPARATUS.

Oil-cups are also provided for lubricating the journals. Upon the journals are bosses to which a curved dust guard is fastened, the guard extending over the gearing. A driven gear-wheel is rigidly mounted upon the shaft and meshes with the previously mentioned gear-wheel. The inner end of the shaft is connected with the gearing in the gear-casing mounted on a plate carried by the vehicle frame. The armature shaft of a dynamo-electric machine is adapted to be rotated from the shaft through the medium of the gearing in the gear-casing. The operation of the invention is as follows: when the vehicle is in motion, the rotation of the vehicle wheel drives the gear-wheel to which the vehicle wheel is keyed. This in turn drives the gear-wheel which rotates the dynamo armature by means of the shaft upon which it is mounted and the gearing in the gear-casing. When it is desired to remove the vehicle wheel for oiling the bearing or for any other purpose, it may be done without disturbing the gearing, since the gear-wheel which is mounted upon the journal is not dependent for its support upon the vehicle wheel, but is supported independently of such wheel upon the journal, carried by a sleeve upon the axle of the vehicle.

A system of house wiring has recently been patented by Joseph W. A. Richardson, of New Orleans, La., the object of which is to provide an arrangement of main-wire conduits so constructed as to be invisible, but in which ready access may be had to any part of the wires contained therein. In carrying out the invention a strip is arranged at the top of the side walls of a room adjacent to the ceiling, and in the face of this strip is formed a series of longitudinal passages or channels, forming conduits in which are disposed the main wires of the system. In the passage at the upper end of the strip are arranged all the low-potential wires, such as telephone, signal, or bell wires. In another passage or conduit are arranged all positive wires, and in other conduits are arranged all negative wires of the lighting circuit of the system, so that the wires of each class are separated from those of the other in channels or passages of their own, and as many circuit-wires as desired may be arranged in the conduits. On the outer face of the strip are arranged two covering strips which are adapted to be removably secured to the strips by screws or otherwise. These cover strips are so arranged that either may be removed independently and without disturbing the other, thus permitting access to either the high or the low-potential wires without uncovering the other. At the base of the side walls adjacent to the floor are arranged strips in which are formed passages or conduits in which are disposed the positive and negative wires of other light or high-potential circuits. On the outer face of this strip are removably secured cover strips, the lower edges of which are rabbeted to enter a grooved retaining strip secured to the floor or the base of the strip. This grooved strip serves not only to retain the cover strips, but also to prevent the passage of water into the passages or conduits of the strips. At a convenient place in the house is arranged a switch-cabinet, to which the terminals of the outside supply wires are brought after entering the building and from which all the conduits for the main wires in the building extend and where any or all of the main wires may be switched to or connected with the supply wires. At such points in the conduit strips as may be desired are arranged outlet or distributing boxes, which are preferably rectangular in shape and formed of metal. These boxes are secured to the inner sides of the strips and project into recesses in the walls or between the thicknesses of the same. In these strips are formed openings, which communicate with the boxes. In each side of the boxes are formed openings, with which the ends of branch conduits are adapted to be connected. Such of the holes in the boxes as are not connected with these conduits are closed by removable plates. The ends of the conduits may be connected with the openings in the boxes by providing an apertured plug having a head and a threaded stem. The stem of the plug is adapted to be passed through one of the holes in the box with the head of the same engaging the inner wall of the box. A jam-nut is then screwed on to the threaded shank against the outer wall of the box, thereby securing the plug in place. The ends of the conduits are interiorly threaded and into the threaded ends are screwed the threaded stems of the plugs,



SYSTEM OF HOUSE WIRING.

thereby connecting the branch conduits with the boxes. The branch conduits are preferably in the form of tubes and are constructed of metal or other suitable material and may be run in any direction through the walls either between the thickness of the same or embedded in the plaster. They extend from the outlet or distributing boxes to such places in the ceiling or side walls of the room as it is desired to use the current and where the conduits are adapted to connect with auxiliary outlet-boxes similar in construction to the other outlet-boxes. To the first mentioned outlet-boxes are connected the side brackets and ceiling chandeliers for the lights. Through the branch conduits are run feed wires which enter the outlet-boxes at one end and are passed through the openings in the rear walls of the strips and connected with the positive and negative wires of the main line. The opposite ends of the feed wires enter the auxiliary boxes where they are connected with the chandelier or bracket wires or with a switch.

Reviews of Current Engineering and Scientific Literature.

Electrotropism of Roots.

An extensive study of electropic phenomena, carried on at Harvard University, seems to indicate that the explanation advanced some two years ago that the turning of root tips toward the anode is most easily accounted for by attributing this reaction to the effect of electrons or electric charges of the ions, rather than to any mere chemical effect of the atoms, is entirely correct and that the conclusion that negative charges stimulate and positive charges paralyze the embryonic protoplasm of plants, is well founded. Seedlings have been grown in ordinary soil and by the water culture method in the presence of an electric current under greatly varying conditions of temperature and current density with entirely uniform results. The least perceptible current passing by the roots has been found in time to overcome the normal geotropic tendency and to turn their tips toward the anode. The passage of a comparatively strong current for a few minutes will produce a marked curvature after two or three hours. Vigorous roots have been deflected ninety degrees from their downward course in half an hour and with the current continued the roots grow horizontally toward the anode, while if the current be discontinued they continue curving until a complete coil is formed, or they may gradually bend downward again forming a double curve. The region of the initial curvature is dwarfed in its growth. There is also a flattening of the root on the concave side of the curve. A microscopic study of these electrically curved roots shows the protoplasms of the side nearest the anode coagulated and killed by the action of the current. Where the roots have been acted upon for but a short time, only a few of the cortical cells are affected, while for longer actions or more intense current the affected zone grows wider and wider and the normal part is practically a straight line at right angles to the path of the current. Very weak currents tend to check growth in length and the roots consequently take on a more stocky appearance. These results are practically uniform, notwithstanding what the ions or electrons are. Distilled water, very dilute acid, gases and neutral salts are apparently alike in this relation, so that it is improbable that the results of these experiments can be attributed to pure chemical causes. It would seem that the all-important factor is the electron or electric charge of the ion; more specifically the positive electron—this being the one which produces the most striking effect. These effects are always in the same direction, as far as is known, causing paralysis or actual death of the protoplasm exposed to the action of the positive charge. Negative electrons seem to be too neutral in their relation to living cells, any effect when perceptible being a stimulation of the protoplasm.—*Abstracted from the American Journal of Science (New Haven), August.*

The Electrical Transmission of Pictures.

Dr. Arthur Korn has devoted considerable time to the subject of the transmission of photographs and pictures by electricity and publishes a booklet in which he has described very precisely and carefully the details of his method. Successful results have been obtained over telegraph and telephone lines for a distance of 800 kilometres. A ray of light is made to pass systematically over the transparent film to be transmitted. After passing through the film it impinges upon a selenium cell, the resistance of which varies proportionately to the amount of light which passes through the photograph. These varying currents pass through the transmission line and are received in a moving coil galvanometer, the pointer of which in moving inserts or takes out resistance in a high-tension circuit, according as the current flowing in the moving coil changes. In the high-tension circuit a small vacuum tube is connected, the illumination of which is proportional to the light passing through the plate at the transmitting end of the line. This vacuum tube now passes over the sensitive photograph paper in synchronism with the ray of light over the transmitted plate and thus a reproduction of the same is obtained. The transmitted film and sensitive paper are each wrapped on a glass cylinder. These cylinders are rotated by motors and synchronized once each revolution. Only one wire is needed for the transmission, with an earth return. In the transmission of half-tone illustrations and handwriting the articles are prepared on metal foil with non-conducting ink. The conducting point travels over the metallic foil and closes and opens the sending circuit, according as it is traveling on a marked or an unmarked space. The receiver used by the author is a modification of the above, the essential point being the use of the vacuum tube fed with the Tesla currents. For a half-tone illustration a strip one-half centimetre wide and ten centimetres long can be sent in one hundred seconds. With the apparatus at present to be had the time taken to transmit a half-plate photograph is half an hour, but the lessening of this time is merely a matter of futher development.—*From Elektrische Fernphotographie und Achnliches.*

The Progress of the Jungfrau Railroad.

The Jungfrau railroad is now open to the station Eimeer, 3,161 metres above the sea level. There are about 1,000 metres of the line to be completed. The last seventy-three will be covered by a vertical lift. The maximum grade of the road already built is about twenty-five per cent. Mr. L. J. Sidler describes the equipment of the road: the power is generated by water at a station at Lauterbrunnen. A second station is to be built at Burglaüenen. The turbines are on the Girard and Francis system, operating under a head of thirty-five metres and generating 2,650 horse-power. The dynamos are the products of the Oerlikon works and Brown, Boveri & Company, Baden. They generate a three-phase current at 7,000 volts. During the winter when the melting of the glaciers which supply the water ceases, power is derived from an auxiliary plant of two gas engines, with a fuel gas producer. Transformers at each station lower the voltage from 7,000 to 500, at which pressure it is used. The electric locomotives of which there are six, represent three classes, depending upon the method of control used during the descent. In two the non-synchronous motors driven by the weight of the train act as generators, delivering current to the main line. A third has an adjustable resistance, which may be used to absorb part of the energy developed in the descent of the train, as it was found in the start that with the small number of trains operating and the large amount of power developed in the descent, there were times at which the generating station was entirely relieved of the load, the dynamos then acting as non-synchronous motors and causing serious difficulties in the operation of the plant. The fourth and fifth locomotives by the Oerlikon works and the sixth by Brown, Boveri & Company, were built with the idea of

entirely absorbing the power generated by the descent. In the first two the motors, while operating as generators, do not have the primary windings traversed by the three-phase current of the line, but are supplied with a continuous current generated by a small six-pole dynamo on the shaft of one of the motors. On the sixth engine the non-synchronous motors during the descent act as continuous current series dynamos. For the safety of the passengers, each locomotive is provided with two electric motors, each of which has a double train of gearing to the rack rail, so that with the breakage of any part, it is impossible to interrupt the connection. The wheels gearing into the rack between the rails are on separate axles from those of the supporting wheels, freeing the latter from stresses due to power transmission. Three independent systems control the descent of the locomotive: in the first the motors are operated as dynamos under load. This will be the usual method of regulating the speed. Besides this there are two independent systems of mechanical brakes: the first consists of two sets of brake shoes, clamping against drums upon the main motor gears, the second an automatic stop brake, acting upon the drum of the motor and throws the action automatically whenever the speed rises twenty-five per cent above the normal. These brakes act upon the rack between the rails; in addition there is an entirely separate safety clutch which grips directly upon the smooth sides of the rack rail. During 1903 nearly 30,000 passengers were carried on the road as far as it is completed.—*Abstracted from Le Génie Civil in the Engineering Magazine, August.*

Self-Exciting and Compounded Alternators.

In this communication some particulars are given relative to recent machines compounded upon the Heyland principle. The Heyland method of self-excitation and compounding does not necessitate any alteration in the standard design, beyond replacing the exciter by a commutator of special construction and winding the magnet wheel with the number of interconnected circuits which are connected to this commutator. Connecting the three sets of brushes to the alternator terminals by means of a small pressure transformer, the machine becomes self-exciting; and if, in addition, the brushes are connected into the armature winding, by the help of a current transformer the machine compounds itself for constant terminal pressure at any load and power-factor. It can also be made to over-compound. Such machines are synchronous, and their method of operation is precisely the same as that of the ordinary synchronous type, except that no hand regulation is required. The alternators must be connected by an equalizing conductor, as in the case of compounded continuous-current machines. Curves illustrating the performance of a 300-kilowatt, three-phase compounded generator, built by Kolben & Company, and designed to give a constant pressure of 5,200 volts at its terminals at all loads, and a power-factor of 0.8, are given. These show satisfactory results, the fall of potential for full load and practically zero power-factor being only 4.8 per cent. The curves show also the relation between the shunt and series excitations which varies with the load and with a fixed adjustment of the shunt regulator, and they indicate that this method of exciting gives a better utilization of the active material than the common method. This machine, with a direct-current excitation corresponding to 5,200 volts, at full load gave on short-circuit only sixty-nine amperes, or 1.7 times the full-load current. Nevertheless, in spite of the heavy armature reaction, the generator compounds exactly for constant terminal pressure at full load and 0.8 power-factor. The dimensions of commutator for this machine are thirty-six inches diameter and five inches effective length. Some results are also given of a ten-kilowatt, three-phase, or eight-kilowatt, single-phase, compound generator of this type. This machine compounds level with a full inductive load, and over-compounds nine per cent on full non-inductive load. The disadvantage that has been met in these compounded generators is in connection with the low-pressure excitation. Considerations of commutation require that this pressure should not be more than thirty volts, which calls for heavy leads between the machine and the regulator on the switchboard. This does not apply to the compounding circuits, as the series transformer is mounted directly on the generator in the position usually occupied by the exciter. This disadvantage is met only in the large generators, and in this case as the cost of the switchboard itself is large, the increase is not serious. However, to get over this, Heyland has recently modified his method, and now suggests the use of an exciter which is compounded, instead of the generator. The exciter is provided with a supplementary interconnected multiple-circuit winding on its field system, in addition to its ordinary shunt winding, the supplementary winding being supplied through a current transformer and commutator, as before. The commutator must rotate synchronously, and can be placed on the shaft of the alternator or driven by a synchronous motor. The exciter, by means of its main shunt winding, furnishes the excitation necessary for the alternator at no load. As the load comes on, the field of the exciter is correspondingly increased, owing to the converted current which is proportional to the load current, and which circulates in its auxiliary winding. When the dimensions of the exciter and alternator field systems are properly chosen, the compounding of the main unit for any load or power-factor can be made exact. Probably the most important application of this method to indirect compounding will consist in its application to existing installations, since at comparatively small expense, the exciters at present in use can be exchanged for compounded exciters, and the generators thus be made to compound for constant pressure or to over-compound.—*Abstracted from the Electrician (London), July 15.*

A Mexican Hydroelectric Plant.

Mr. Robert McF. Doble describes at length in this article the hydroelectric power developments and high-potential, long-distance transmission recently completed by the Guanajuato Power and Electric Company in the states of Michoacan and Guanajuato, Mexico. The Guanajuato Power and Electric Company, under a concession from the department of encouragement, colonization and industry of the republic of Mexico, constructed a canal, pipe line, power-generating station, transmission line, substations and distributing systems for developing and marketing the motive power of 283 cubic feet of water per second from the Duero river. The water supply is derived principally from numerous springs found all over the extensive watershed area. The slight variation in the volume discharged demonstrates that there is an underground storage of great capacity. The Duero river is formed by the Chilchota and Camecuaro rivers, each of which is fed by tributary mountain streams from elevations varying from 5,000 to more than 12,000 feet above sea-level. The masonry dam is built of volcanic rock, the interior being laid up with lime mortar, and the exterior with Portland cement. It is a curved structure with a

radius of 88.19 metres, the length of the crest being eighty metres. Its elevation is 1,662.40 metres above sea-level. The canal is 6,650 metres long, of trapezoidal section, four metres wide on the bottom and 2.10 metres deep. Its uniform slope is 1 to 2,500. The carrying capacity is 283 cubic feet per second. The pipe line is 3,300 feet long, with no lateral bends. The power-house has masonry walls built of native volcanic rock. The roof is of galvanized iron, supported by steel roof trusses and lined with an anti-condensation lining. Its inside dimensions are 200 feet in length, thirty-two feet wide. The floor is of cement. A low wall separates a length of forty feet at the easterly end of the building, where the transformers are placed. This portion of the building is two feet lower than the main room, and is provided with drains into the tailrace. Each water-wheel has fifteen huge buckets, more than two feet in width, and weighing 254 pounds apiece. The buckets are accurately fitted to the rim of the cast-iron wheel centre, and secured thereto by means of two fitted steel stud bolts. The entrance edges are sharpened, the hydraulic surfaces are ground smooth and painted, and each bucket is brought to a standard weight, so as to obtain a dynamic balance. The generators are revolving-field, engine-type, 2,300-volt, three-phase, sixty-cycle, 200-revolutions-per-minute machines, rated at 1,250 kilowatts, but designed for a twenty-five per cent continuous overload. The total weight of the revolving element, consisting of the field, the shaft and the two water-wheels, is about 50,000 pounds. The speed is regulated by means of a governor operated by an oil-pressure system actuating the deflecting hoods. Continuous current for exciting the alternators is supplied by two 120-kilowatt, 500-revolution, self-contained, hydroelectric units, either of sufficient capacity to excite the four generators, so that one exciter is a spare. The current is conveyed from the machines to the switchboard, and thence to the step-up transformers, through lead-covered, rubber-insulated copper cables laid in shallow covered ducts in the cement floor. The current passes from the generators through 600-ampere, oil-break switches, each installed in a separate concrete department of the 2,300-volt bus-bars. The field rheostats are supported on four-inch eye-beams above the switchboard, and are operated by means of chains and sprocket wheels. The bus-bars, oil switches and wiring for the instruments are all back of the board and out of the way. The switchboard has seven marble panels, one for each generator, one for each exciter, and one for two step-up transformer circuits. From the switchboard the 2,300-volt current is conducted to the 1,800-kilowatt static transformers, where the potential is raised to 60,000 volts for transmission. The transformers are delta-connected on the low-potential side, and "Y"-connected on the high-potential side, the neutral being grounded. The transformers are of the oil-insulated, water-cooled type. The tanks are twelve feet in height, and occupy a floor space of three by six feet. From the step-up transformers the current is conducted to the transmission line, the wires passing out of the building through circular openings in the wall to a set of 60,000-volt disconnecting switches mounted just outside of the building, and thence to the first tower of the transmission line. On the inside wall of the building three rows of 60,000-volt lightning arresters are mounted, being connected through switches to the outgoing leads. The 101-mile, 60,000-volt transmission line makes use of a hard-drawn copper cable, metal pins, cross-arms, towers for supporting the insulators, and unusually long spans. The conductors are nineteen-strand hard-drawn copper cables, approximately three-eighths of an inch in diameter. The insulators are larger and heavier than those generally used, and were required to stand a test potential of 120,000 volts for five minutes. They are over twelve inches in height and fourteen inches in diameter, and weigh about fifteen pounds. The pins are of cast iron, conical in shape, and cored hollow. The towers are special forty-foot four-post galvanized steel structures made of three-inch by six-inch by three-sixteenth-inch angles, braced and staid with smaller angles and rods. The towers are spaced 440 feet apart, except near Guanajuato, where the nature of the ground necessitated the use of a few sixty-foot towers and spans up to 1,320 feet in length. The line is divided into four sections of about twenty-five miles, and is in charge of a superintendent whose headquarters are at the middle storehouse. At each of the three division points there is a first-class storehouse, a set of 60,000-volt disconnecting switches in the main line, a line foreman and patrolman, both mounted. In the middle of each section there is a second-class storehouse in the care of a mounted patrolman. At Guanajuato the transmission line cables enter the substation through a set of 60,000-volt disconnecting switches, the same as at the generating station. The Guanajuato substation is 113 feet long and eighty-nine feet wide. The wires enter the building through a set of lightning arresters with disconnecting switches, and go to a bank of oil-insulated, water-cooled transformers, where the potential is reduced to 15,000 volts. From the step-down transformers the cables pass through ducts under the floor to the switchboard, thence to the six 15,000-volt, three-phase distributing circuits, each of which is equipped with lightning arresters and air-break switches with tube fuses. At the mines and mills where the electric power is used, the potential is reduced in three-phase transformers from 15,000 volts to 460 volts for motor service. The Guanajuato two-phase, 2,100-volt lighting system is supplied from a bank of 150-kilowatt, three-phase to two-phase transformers with a feeder regulator in each phase. Power is supplied to various small industries throughout the city, including three grist mills, a foundry, a wagon works, paint factory, and various pumps used in irrigating the strawberry fields. The inception and development of the enterprise are due to Mr. Leonard E. Curtis. He proceeded to Guanajuato to examine the title to certain mining properties, and while there investigated the possibilities of the water powers. He was later joined by Mr. Henry Hine, who undertook the financing of the proposition, and the matter was subjected to an engineering examination, which was made by Robert McF. Doble, of San Francisco; H. H. Filley, of Kansas City, and Charles T. Main, of Boston. This report was favorable. The preliminary examination was made in March and April, 1902, construction was begun in the fall of the same year, and in October, 1903, the plant was put into regular operation.—*Abstracted from the Engineering Magazine (New York), August.*

Convention of the Society of Chemical Industry.

The Society of Chemical Industry will meet in New York on September 8, 9 and 10. Delegates will be present from England, Germany, Holland, Australia, India and the Straits Settlements. Sir William Ramsay, who has done some of the pioneer work in radium, is the retiring president of the society. This will be the first meeting of the society in America.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

The Thomson High-Torque Induction Meter.

The General Electric Company, Schenectady, N. Y., has produced a new design of the Thomson high-torque meter. All of the characteristics of electrical performance for which this meter was prominently known have been retained or improved in the new design, while improvements have been achieved in the arrangement of parts, the appearance, and the reduction of size and weight.

The manufacturer states that the limitations to which many induction meters are subject are entirely overcome in the new high-torque meter, and circuits of widely different characteristics can be accurately metered with this new device. The turning moment is much higher than has formerly characterized most induction meters. The weight of the rotor has been reduced to the lowest practical value; and in conjunction with the high torque produces a factor of "torque per unit weight" far in excess of other meters. A description of the various parts follows.

The various elements are combined in a neatly designed rectangular iron case, provided with three supporting lugs. The elements are fastened to a spider or casting, which is in turn secured to the meter case by two retaining screws and two sealing pins. Removal of the screws and sealing pins allows the entire mechanism to be quickly and easily removed for inspection. The cover is held in position by means of two studs and wing nuts which firmly clamp it down on a felt packing, thus rendering the meter dust and insect proof. Two rectangular openings fitted with glass windows are arranged so that both the register dial and the meter disc can be plainly observed.

The meter register is of the four-dial type, and on meters of less than fifteen-kilowatt capacity reads directly in kilowatt-hours without the use of a multiplying constant. One division of the lowest reading dial is equal to one kilowatt-hour.

Meters of capacities in excess of fifteen kilowatts have a multiplying constant of 10, 100, 1,000, etc.

The rotating element consists of an aluminum disc mounted on a small steel shaft, the lower end of which carries a removable pivot and the upper end a suitable worm which transmits the disc movement to the meter register. If repairs are at any time found necessary, the disc can be removed without disturbing the damping magnets.

The simple adjustable device, consisting of a small sliding rectangular conductor which, by means of a lever, can be moved backward or forward over the meter disc, permits a wide adjustment at light load.

The meter is so designed as to avoid creeping on potential. This is a feature which will be appreciated by all users of induction meters.

The magnetic circuit is practically closed on itself and projected fields tending to demagnetize the damping magnets are prevented. The magnets are further

THE THOMSON HIGH-TORQUE INDUCTION METER.

safeguarded by their position, which is at right angles to and at a maximum distance from the coils.

For meter jewels, carefully selected Ceylon sapphires only are used. The strength of the supporting spring beneath the piston of the jewel mount in relation to the weight of the moving element of the meter is the subject of careful test in connection with every jewel screw manufactured. All springs not within the proper limits are rejected.

A device securely locks the moving parts in position. This device is so arranged that backing out the jewel lifts a supporting ring, raising the pivot from the jewel and holding it firmly in position. This supporting ring automatically releases the disc when the jewel is raised into position.

All magnets used in the instruments are subjected to rigid inspection and an aging process.

The high-torque induction meter is designed and adjusted to secure the highest possible inductive load accuracy and to record true kilowatt-hours, either upon an entirely non-inductive load, such as incandescent lamps, or upon highly inductive loads, as fan or other motors. In view of the fact that 125 and 133-cycle systems are now quite generally being converted to sixty cycles, all meters ordered for use on 125 or 133-cycle systems are provided with means for immediate reconnection for sixty-cycle service to provide for a possible future change. Meters ordered for sixty-cycle service are not provided with this feature. Variation in voltage or frequency of ten per cent either side of that for which it is calibrated does not affect the meter.

For the convenience of companies which wish to test their meters before installation, a testing loop has been provided, located on the left-hand terminal board. By unsoldering this loop the meter can be tested on separate potential circuits.

In installing, the supporting screw may be inserted prior to hanging. The meter may then be hung on this screw, the hole for the supporting screw being keyholed. This permits of easy and immediate leveling, after which the other screws may be inserted.

The meter is manufactured as a standard device in both two-wire and three-wire form. No tributary external devices are necessary for either two-wire or three-wire application, and current transformers are not used except in connection with sizes in excess of 300 amperes, two-wire, and 150 amperes, three-wire.

The meter is finished in black enamel and can be furnished with glass covers. Bulletin No. 4379 gives a detailed description of this meter.

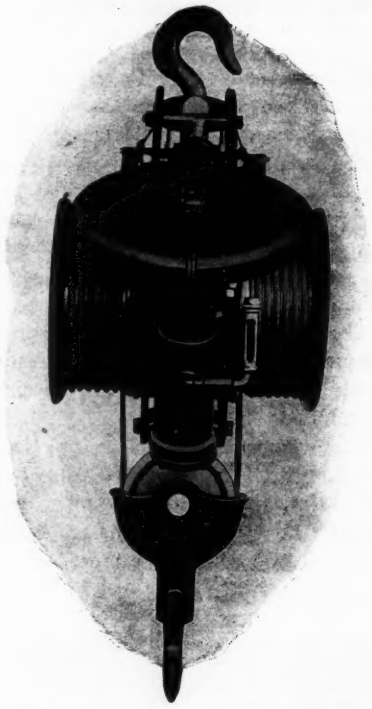
Telephoning from Moving Cars.

It is announced that the cars of the St. Louis, St. Charles & Western Railroad, running between St. Louis, Mo., and St. Charles, about twenty miles, will be equipped with telephones by the American Car Telephone Company, enabling passengers in the cars to communicate with offices or stations along the line, while under way. The connection between the car and stationary telephone will probably be by a separate trolley and wire.

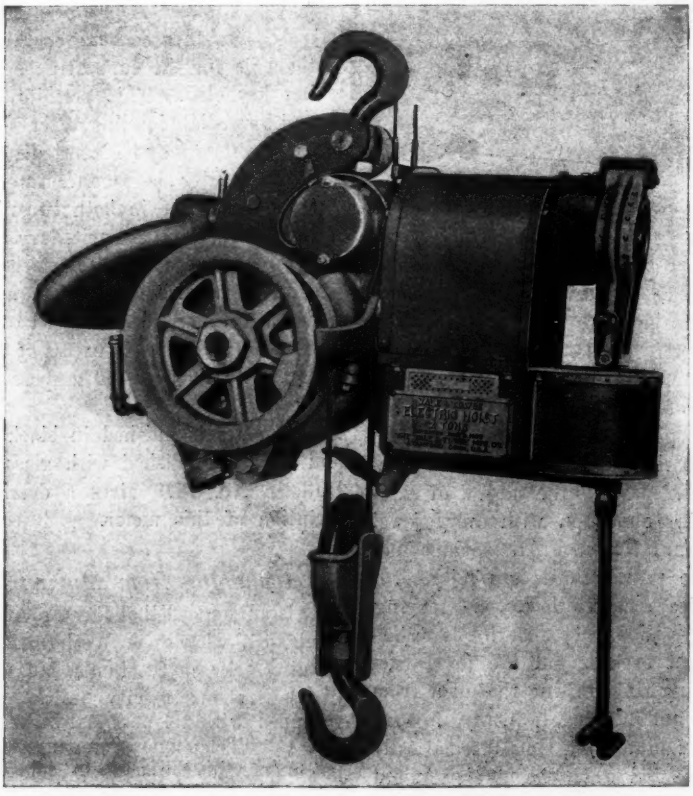
The Yale & Towne Electric Hoist.

The hoist shown in the accompanying illustrations, made by the Yale & Towne Manufacturing Company, New York city, is designed to meet a demand for a simple, convenient and durable power hoist. The manufacturer states that it is made to withstand the roughest usage and give satisfactory service in the hands of inexperienced workmen.

The material used throughout is of the best obtainable quality, and all parts are made to gauge, thus securing interchangeability. The motor is placed above the oil-submerged parts of the hoist, and the motor-shaft bearings prevent the possibility of oil entering the motor. The improved oiling devices preclude the possibility of heating from overload or injury from the high temperatures usually existing near the ceiling. The load is taken on wire hoisting rope of tough steel, wound on grooved drums that are keyed direct to the main shaft. At the bottom hook the steel hoisting rope passes around an equalizing sheave, thereby balancing the strain. All parts under tension or subject to transverse strain are forged steel or wrought iron. The hoist balances properly on its single upper hook whether loaded or empty, and pulls in a true vertical line throughout the lift. The single swivel hook suspension allows the hoist to pull as well at any angle. The working parts are enclosed in an oil-tight casing, which excludes dust and water, at the same time ensuring lubrication. An automatic cutoff prevents the load being hoisted too high, and even should the motor brake become inoperative, the hoist can not run away.



SHEAVE AND BLOCK, ELECTRIC HOIST.



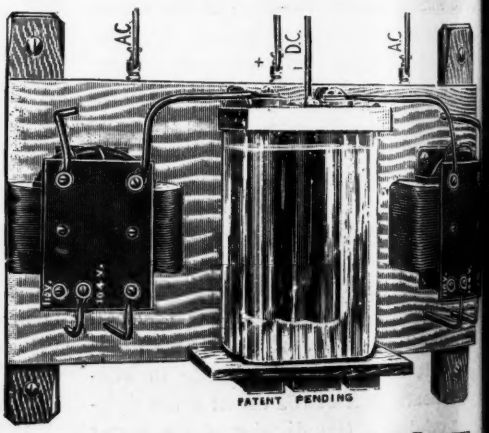
ELECTRIC HOIST, COMPLETE, SHOWING JOINTED CONTROLLER ROD.

The hoist is operated from the floor, and is regularly equipped with a telescope controller rod, enabling the workman to control it from a point in full view of his work, without depending on signals to a crane operator. Pendant cords or chains will be furnished if preferred, but the rod-controlling device gives more accurate control of the load, and is so made that it can not catch on any obstruction and start the hoist when traversing on a crane or runway.

The Churcher Alternating-Current Rectifier.

The Churcher system of alternating-current rectifiers, manufactured by the Electrical Appliance Company, of Cincinnati, Ohio, is a combination of devices designed to receive any alternating current and deliver a uni-directional current suitable to operate any electrical device requiring a direct current. This apparatus has been gradually and systematically developed along lines suggested by actual practice, and, the manufacturer states, will meet all claims made for it.

The rectifier has no moving parts, and requires no wiring, other than the two wires leading to it from the source of alternating current, and the two wires delivering the direct current. The rectifier may be mounted on a board and attached to a wall, and can utilize space which would not be of value for any other service. It is easy to install, and, owing to its simplicity, may be easily taken care of. The solution is stated to be harmless, and the chemicals are cheap and readily obtained at any drugstore.



THE CHURCHER ALTERNATING-CURRENT RECTIFIER.

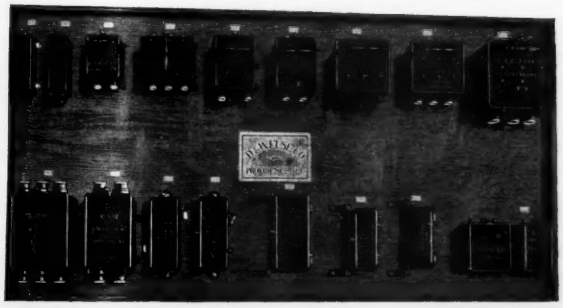
In sizes below three kilowatts it is stated to be more efficient than a motor-generator. The actual working efficiency, of course, varies with the load, but not over such wide range as the mechanical

apparatus. The rectifier at full load will have an efficiency of over fifty per cent, and approximately forty per cent at one-quarter load. The operating cost, other than the charges for alternating-current supply, consists of the solution loss, and wear on the aluminum and composition electrodes, which approximates four cents per 100 ampere-hours of direct-current supply at forty volts. At lower voltage the cost is practically the same, and increases in proportion with each four volts added to the direct current delivered.

The Electrical Appliance Company has published full descriptive matter, with illustrations and price lists of standard types, which it will be pleased to send to any one interested upon application.

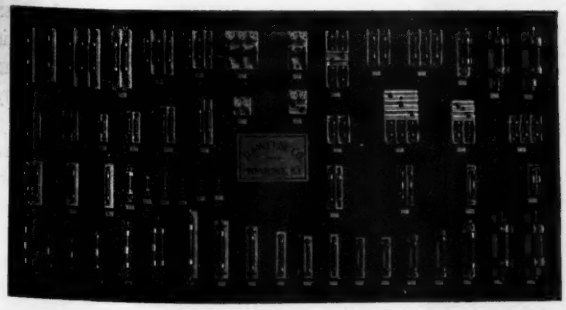
The World's Fair Exhibit of the D. & W. Fuse Company.

The accompanying illustrations show two sample boards which the D. & W. Fuse Company, 407 Pine street, Providence, R. I., has on exhibition at the St. Louis Exposition. This exhibit is in connection with the agent of the company, the Western Electric Company, of Chicago, and is located in section 17 of the Electricity Building.



BOARD NO. 1, SHOWING D. & W. FUSE EXHIBIT AT THE WORLD'S FAIR.

Board No. 1 displays a complete line of boxes designed to operate satisfactorily on circuits ranging from 250 to 6,000 volts, and comprises the following types: transformer cutouts, service switches and boxes, entrance cutouts and railway cutouts, all equipped with enclosed cartridge fuses, the types of contacts of the fuses varying according to the conditions for which the boxes are designed, some having the well-known clamp contact, where extreme vibration renders a clip fuse impracticable, while in other boxes the spring clip fuse is used.



BOARD NO. 2, SHOWING D. & W. FUSE EXHIBIT AT THE WORLD'S FAIR.

On board No. 2 there is mounted a complete line of low-potential cutouts of the spring clip type, and also the type "A" or screw clamp contacts. This applies also to the 500 and 2,500-volt cutouts and fuses. In addition to the bull's-eye indicating cartridge fuses, several other specialties are shown, such as reloading plug fuses and several types of panel fuses. There are also telephone, telegraph and fire-alarm protectors.

The boards are made of cherry, eight feet by five feet, with aluminum nameplates under articles giving the catalogue number.

Supplies for the Panama Canal.

At present no important purchases of tools and machinery for use on the Panama canal are being undertaken. The only work being done is in the Culebro cut, where 900 negroes of the old French company are employed.

It is estimated that the inventory of the machinery and materials taken over from the French company, originally listed at $29,000,000, will be about $2,000,000.

The purchasing of large machinery and equipment will not begin for probably six months. At present the only supplies being bought are for sanitation and disinfection.

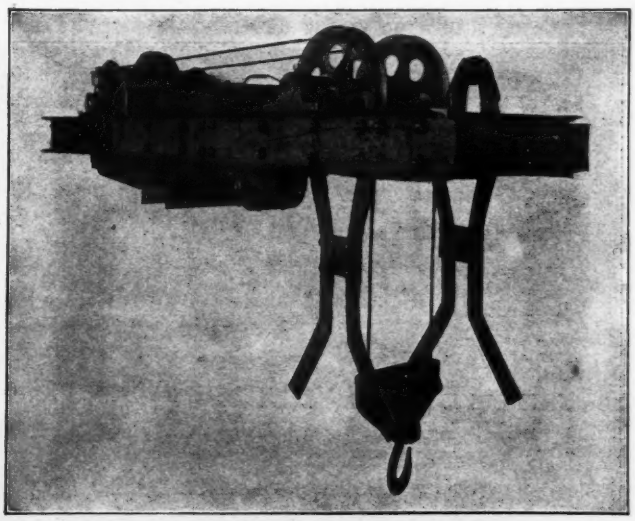
Portable Electric and Hand Hoists.

The United Telpherage Company, 20-22 Broad street, New York city, is equipping many industrial works with its new line of portable electric and hand hoists. These have large drums and large sheaves, with a minimum headroom for the hoist, and are arranged for a distributed load to be suspended over the telpher and trailer. No expense or labor has been spared in making these hoists reliable and efficient. They are convenient to handle, as compact as possible, and are light in proportion to the work done. Above all, the company claims they are absolutelv safe. There are many new and important features in the design of these hoists, especially in the system of control. All the parts have been made interchangeable.

In order to secure steadiness in operation with a suspended load, the hoist is supported at the ends, giving a long base and preventing swaying. The load, if carried in a bucket, is held by means of a brace from the hoist.

With these portable hoists all the gearing runs in oil, and all bearings are self-oiling, and ball-bearing thrusts are employed. The motors are ironclad, water and dust-proof, with large commutators and ample mica insulation.

The accompanying illustration shows a heavily constructed hoist with exceptionally large drums and sheaves, for heavy lifts and high speeds.



PORTABLE ELECTRIC HOIST, WITH GUIDES.

When the generating station on the great Ohio falls, near Louisville, Ky., is completed, it will furnish more power than any other single plant. Two hundred thousand horse-power will be generated and distributed to Cincinnati, Evansville, Indianapolis and Louisville.

The World's Fair Exhibit of the De Laval Steam Turbine Company.

The De Laval Steam Turbine Company, Trenton, N. J., is making an interesting and instructive exhibit in the Mining Gulch, St. Louis Exposition. This is an operative exhibit, and machines have been installed as follows: one twenty-horse-power electric motor, direct-connected to a De Laval centrifugal pump; one fifty-five-horse-power De Laval steam turbine, direct-connected to a De Laval centrifugal pump; one fifty-five-horse-power De Laval steam turbine, high-pressure centrifugal pump, and one thirty-horse-power De Laval steam turbine, direct-connected to a twenty-kilowatt, direct-current generator. This exhibit is shown in one of the accompanying illustrations. The other illustration shows a 300-horse-power, 200-kilowatt turbine-dynamo, which is exhibited in connection with the Bullock Electric Manufacturing Company's exhibit in the Electricity Building.

THE WORKING EXHIBIT OF THE DE LAVAL STEAM TURBINE COMPANY, MINING GULCH, WORLD'S FAIR, ST. LOUIS, MO.

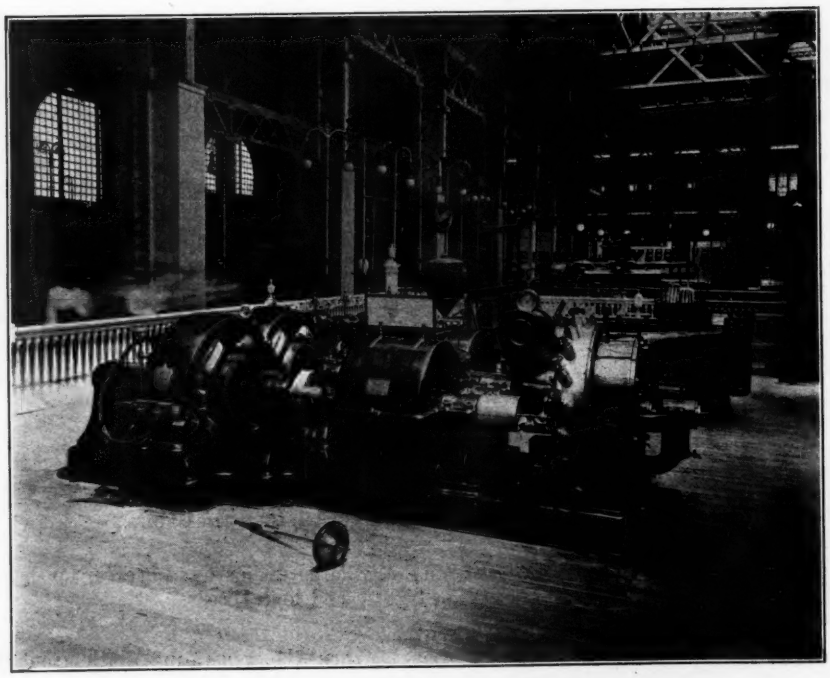


EXHIBIT OF THE DE LAVAL STEAM TURBINE COMPANY, IN CONNECTION WITH THE BULLOCK ELECTRIC MANUFACTURING COMPANY, ELECTRICITY PALACE.

The Remarkable Performance of a Storage Battery.

On July 22 a remarkable ride was made in which, on one charge, an electric car ran from Providence to Boston and returned—a distance of probably 105 miles. The distance from Providence to Boston was covered in three and one-half hours, at about the rate of fifteen miles an hour. The trip was made without accident and the hill climbing done easily. Three consecutive hills, a distance of one and one-quarter to one and one-half miles, were covered in ten and one-half minutes. The amperage rose to sixty-five and on the heaviest part of the incline, to seventy-six for about one-half minute on each hill. The average demand for the hills was from fifty to fifty-five amperes, the average on the level from twenty-two to twenty-five. The battery stood at two volts per cell at the end of the trip, so that there were probably fifteen or twenty miles left. This performance places the electric car where it can be depended upon for a day's run and removes almost entirely the objection to electric automobiles. The Rhode Island Electromobile Company, Providence R. I., are the builders of the above car. The weight of the battery of forty-two cells is 1,219 pounds, and of the battery and carriage together a trifle less than 2,000 pounds.

Fire Protection of a Seaside Amusement Resort.

In order to ensure adequate fire protection for the buildings which make up the amusement resort called "Dreamland," at Coney Island, N. Y., a contract has been closed with the H. C. Vogel Automatic Sprinkler Company for installing an automatic sprinkler system in every theatre and other buildings.

The electric tower at "Dreamland," one of the exhibition features of the state, contains tanks holding 120,000 gallons of water. A ten-inch pipe connects with all the buildings, and will be attached to the sprinklers on the ceiling of each building. In addition to the sprinklers, the two hydrants in the Electrical Building are so constructed that, in case of any stoppage of the flow from the reservoir, water can be forced into the sprinkler system by the two electric pumps in the "Dreamland" power-house. The cost of the sprinkler equipment is $30,000.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

ELECTRIC LIGHTING FOR THE PHILIPPINES—The contract for the first isolated electric lighting plant ordered by the provincial board of the Philippines has been placed. The plant will be installed by a local electrical contractor in Manila.

NEW YORK POWER COMPANY SOLD—It is stated that the property of the Empire Power Company at Scoharie Falls, near Amsterdam, N. Y., has been taken over by the Hudson River Power Company. Improvements are now being made to the plant. A transmission line will be constructed from Amsterdam to Speir's Falls, connecting the Glens Falls and Scoharie power plants.

EXTENSIVE RAILWAY WORK IN NEW YORK STATE—It is reported that at the beginning of construction of the Rochester, Syracuse & Eastern Railroad, next week, an expenditure of $6,000,000 will be involved. The work was authorized at a meeting of the directors of the road on July 26. Considerable grading will be necessary, and it is estimated that the cost of this alone will be in the neighborhood of one million dollars. Rochester and Syracuse will be the terminals of the line, which will pass through many prosperous manufacturing towns. Construction work will be heavy, and there will be a number of important bridges.

BUFFALO GENERAL ELECTRIC COMPANY TO INCREASE ITS STOCK—Holders of stock in the Buffalo General Electric Company have received notices that a meeting will be held in the offices of the company in the Fidelity Building, Buffalo, N. Y., on August 17, to vote on the proposition to increase the capital stock of the company from $2,400,000 to $5,000,000. The reason given by Charles R. Huntley, vice-president and general manager of the company, for the proposed increase is the necessity of getting into position to meet the growing demand for electricity. The Buffalo General Electric Company was organized in 1890, with a capital stock of $1,800,000. Its president is Daniel O'Day, of New York city.

NEW OREGON ELECTRICAL ENTERPRISE—Articles of incorporation of the Portland Southern Electric Railway Company have been filed at Salem, Ore. The capital stock of the corporation is given as $1,000,000, and the incorporators of record are L. B. French, of Detroit, Mich.; W. J. Cook, of Astoria; M. J. Kinney, J. W. Waterberg and C. W. Miller, of Portland, and James H. Albert, of Salem. This is a part of the movement to construct an electric railway between Salem and Portland. While the ultimate object of the company is to construct a road as far south as Eugene, the most urgent portion of the proposed road will be between Salem and Portland, and it is the declared intention of the promoters to build the line between these two points within the next twelve months. The company will get all the power it needs from the Sandy river, and asks no subsidy of any character, except the right of way.

RUSSIAN ELECTRICAL ENTERPRISE—Advices from St. Petersburg, Russia, state that there is considerable talk in electrical circles of adopting electric traction on the Trans-Siberian Railroad. It is stated that in the near future it will be necessary to operate from forty to fifty trains per day. The speed of the trains, under present conditions, is limited by light rails, by the bad profile of the road, and by lack of water. The last-named difficulty experts say can be overcome by the construction of more suitable ducts, or by using more powerful locomotives with tenders of large capacity. According to Count A. F. Lubienski, one of the leading Russian electrical experts, it would prove economical to establish electric traction on some sections of the road. Nothing is said about the method of generating the electricity, and it is quite improbable that this scheme will be undertaken for some time.

PITTSBURG & ALLEGHENY COMPANY TO EXTEND ITS LINES—Plans are being prepared by the officials of the Pittsburg & Allegheny Telephone Company for the connection of a number of additional independent telephone systems within a radius of about 100 miles of Pittsburg with a long-distance service during the next three months. When the work is completed the service will be extended to Butler, Johnstown, Wheeling and other portions of western Pennsylvania and West Virginia. It is the intention of the company to extend the northeastern lines to Buffalo and Syracuse, N. Y. On August 22 application will be made to the governor for a charter for the Pittsburg-Butler Telephone Company, through the establishment of which it is proposed to provide long-distance service to Butler and the adjoining neighborhood. The rights of way have been obtained by the company. The applicants for the charter are J. G. Splane, John S. Weller and T. J. Shuffin.

MEXICAN ELECTRICAL NOTES—A contract has been secured from Pedro Alvarado for a complete electric pumping equipment at his extensive mines in Parral, Mexico. The contract calls for both station and sinking pumps of a special high-lift turbine type. The pumps will operate on a 750-foot head. They will be direct-connected to special water-proof motors of 130 horse-power each. Enrique Silva, of Penjamo, state of Guanajuato, Mexico, has applied to the authorities for a concession which will permit of the construction of an hydraulic plant on the river Angulo or Zacapu, located in the state of Michoacan, district of Puruandiro, for generating motive power. It is proposed to use 4,000 litres of water per second. Dr. Carlos Fenelon and Dr. R. W. Wallace and associates, who recently purchased the Barranca del Oro mining property, are to install an electric power plant and to build an electric traction system between the mines and the mill. The Palmillas Railway Company will construct an extension of its line from the state of Michoacan to the state of Morelos, Mexico. The Portezuelo Light and Power Company, of Puebla, has ordered a 4,300-horse-power outfit, consisting of two 1,300-horse-power water-wheels and one of 1,700 horse-power. The machines will be built by the Pelton Water Wheel Company, and will be direct-connected to General Electric generators.

WESTCHESTER COMPANY'S FRANCHISE SIGNED—Mayor McClellan signed, on August 3, the franchise passed at the last meeting of the board of aldermen, granting the right to the New York, Westchester & Boston Railway to cross certain streets in the borough of the Bronx. This is the second time the application has come before the mayor. Last spring it was vetoed, on the ground that no provision was made for compensation to the city. The application of the Portchester Railroad Company, the rival of the New York, Westchester & Boston, and between whom bitter contentions have prevailed for several years, has not been passed upon by the railroad committee of the board of aldermen. The Westchester company was incorporated in 1872. By an oversight no affidavit was filed certifying to $1,000 of stock for every mile of proposed railroad, as provided by law. In spite of this defect in its charter the company pursued operations until 1873, when its value depreciated, and after some litigation the road passed into the hands of a receiver in 1876. In 1881 William R. Van Pelt acquired the rights of the company, by order of the Supreme Court, for $5,500. He then organized the East River & Connecticut Company, but failed to raise the capital to build a road. Nothing more was heard of the road for twenty-two years. In 1903 the present group of capitalists controlling the venture secured a charter by act of the legislature. At a recent meeting of the stockholders it was voted to raise the capital stock from $1,000,000 to $20,000,000. The contractor for the road is James P. McDonald. The contract calls for the completion of the work in two years. William L. Bull is president of the company. The road will extend from 138th street, New York city, to Eastchester, twenty-five miles, with a branch from Pelham to White Plains, and one from Clason's Point to Throg's Neck.

BELL TELEPHONE COMPANY'S LONG-DISTANCE WORK—Work has been started on the new long-distance telephone wires for the Bell Telephone Company from Philadelphia to New Orleans, a distance of some 1,260 miles. This is said to be a small part of the

extension which is proposed to the Bell system. It is estimated that an expenditure of $4,000,000 is involved in the new lines and in extensions to existing circuits.

RECEIVER APPOINTED FOR VIRGINIA PASSENGER AND POWER COMPANY—Judge Mullen filed an opinion at Petersburg, Va., on July 30, in the case of George E. Fisher against the Virginia Passenger and Power Company, *et al*, It grants Mr. Fisher's plea for the appointment of a receiver, taking the ground that the company is insolvent and that an accounting is necessary to protect the rights of all concerned. This is adverse to the Gould interests, at whose instance a short time ago Judge Waddill appointed receivers for the whole system, of which the Passenger and Power Company is but a part. The latter petitioners based their contention on the ground that it was necessary to prevent the wrecking of the system by the harassing suit of Fisher. Counsel for the Gould interests in the Petersburg case will appeal to the Supreme Court.

ELECTRIC LIGHTING.

SHEBOYGAN, WIS.—The electric light company will spend $37,000 in rewiring its system.

GUTHRIE, OKLA.—It is stated that an electric lighting plant may be established at Tonkawa.

REDDING, CAL.—The Shasta Power Company has been granted a franchise by the board of city trustees.

PEABODY, KAN.—A company has been organized here among local people to establish an electric light and cold storage plant.

SPRING VALLEY, WIS.—The village board has adopted plans and specifications for a municipal electric lighting plant, to cost about $10,000, and to be completed this fall.

BATAVIA, N. Y.—The property of the Consolidated Gas and Electric Company in Batavia will be sold by Judge North, as referee, on August 29. The sale will be on the foreclosure of the $80,000 mortgage held by the Rochester Trust and Safe Deposit Company, as trustee.

ALTURAS, CAL.—A 400-horse-power lighting plant is being installed on Pine creek, about seven miles from Alturas. The electric current will also be used for operating commercial plants. The capacity may be increased at any time, as the water power is sufficient to generate 2,500 horse-power.

TAMPA, FLA.—The Tampa Electric Company is now preparing to erect and install one of the largest electric power-houses in the South. The plant will be located on the Hillsborough river, on the site now occupied by the temporary plant. The frame building housing the temporary plant will be removed and the brick structure erected in its place, covering considerably more ground than the present structure. The plans for the new plant and building have already been prepared. The building will be fifty by one hundred feet, and the new boilers and machinery will give a capacity of 1,000 horse-power. Ground has been broken, and the company expects to have the new plant in use by November 1. During erection and installation, the temporary plant now on the ground will continue in use.

BOSTON, MASS.—The gas and electric light commissioners have given a hearing on the petition of the Greenfield Electric Light Company for an issue of $35,000 of new capital stock. The company was represented by its president, Frederick E. Wells, and its treasurer, A. J. Doolittle. Last September the company received permission to issue $100,000 in bonds for permanent improvements. The new stock is wanted for the dam in the Deerfield river, for a power station and equipment. The company will have about 1,200 horse-power at the dam, and this is expected to be enough except during a few of the driest weeks in summer. It is thought that auxiliary power will be had from a steam plant. The total investment will be about $125,000. The dam will probably be finished in September and the entire plant by October 1.

OBITUARY NOTICES.

DR. ISAAC ROBERTS, F. R. S., died at Crowborough, England, on Sunday, July 17.

JOHN DARE, formerly editor of the *Telephone Magazine*, Chicago, died at Colorado Springs, where he had been seeking relief from lung trouble. The funeral took place at Kokomo, Ind.

AUTOMOBILE NOTE.

AUTOMOBILE RACES—The American Automobile Association has sanctioned the following automobile races: August 12 and 13—Automobile Club of Buffalo, Kenilworth track, Buffalo, N. Y.; August 15 to 20—North Jersey Coast Automobile Association, races and carnival, Long Branch, N. J.; August 19 and 20—Cleveland Automobile Club, Glenville track, Cleveland, Ohio; August 21—George B. Sidener, St. Louis Fair Grounds Association Race Track, St. Louis, Mo.; August 26 and 27—Motor Club of Detroit, Grosse Point track, Detroit, Mich.; Sept. 16—Dutchess County Agricultural Society, Poughkeepsie, N. Y.

LEGAL NOTE.

PENNSYLVANIA RAILROAD COMPANY STILL AFTER WESTERN UNION WIRES—A cross bill to its suit against the Western Union Telegraph Company has been filed in the United States Circuit Court, Pittsburg, Pa., by the Pennsylvania Railroad Company. The bill asks the Court for a perpetual injunction against the defendant company, to restrain it from using any portion of the telegraph lines along the line of the Cleveland & Pittsburg Railroad, claiming the defendant company has no right to the use of the poles and wires, as all agreements and contracts made between the companies are now void. A partition of the property or the sale of the telegraph lines is also asked.

PERSONAL MENTION.

MR. A. L. POND has been reelected superintendent of the waterworks and electric light plant at Coldwater, Mich.

MR. A. L. DABNEY has been elected manager of the waterworks, sewers and electric light plants at Greenwood, Miss.

GEORGE L. GUERTIN has been made chief despatcher of the eastern district and Colby branch of the Colorado division of the Union Pacific system.

MR. C. A. ANDERSON, who has been representing the Stanley Instrument Company, of Great Barrington, Mass., in Europe, has returned to the United States.

MR. C. A. ECK, president of the Eck Dynamo and Motor Works, Belleville, N. J., has sailed for Sweden. It is expected that Mr. Eck will make a stay of some two or three months.

DR. F. A. C. PERRINE who recently resigned from the vice-presidency of the Stanley Electric Manufacturing Company, has been elected president of the Construction Company of America.

FRANCIS DRAKE, the mining expert of Johannesburg, South Africa, has been visiting the exposition at St. Louis. Before returning he will make considerable purchases of machinery and equipment.

PROFESSOR BLONDLOT has been awarded the Lecompte prize of 50,000 francs by the Paris Academy of Science for the most interesting work in physical science. The research was on the N-ray.

R. R. HAINES, manager of the Postal Telegraph-Cable Company at Los Angeles, Cal., has retired from active service. Mr. Haines has been employed in the telegraph service over a period of fifty-six years.

MR. MAX OSTERBERG, consulting electrical engineer, New York, was taken suddenly ill a short time ago, and while physicians have not given up hope of his recovery, it is probable that he will not be able to return to his former duties.

PROFESSOR GARDNER S. WILLIAMS, member of the American Society Civil Engineers and professor of experimental hydraulics, Cornell University, has been appointed to the chair of engineering in the University of Michigan.

MR. CYRUS O. BAKER, the well-known platinum refiner, is writing to his friends from Spitzbergen, the land of perpetual ice and the midnight sun. Mr. Baker is making a lengthy tour of the northern countries, both as a matter of recreation and business.

MR. S. WOLFF has been made district engineer for the Bullock Electric Manufacturing Company at Cleveland, Ohio. Until recently Mr. Wolff was foreman of the testing-room at the Cincinnati works of the Bullock company. For a short time he was in charge of an installation in Mexico, under the direction of Mr. Frank P. Rae.

Returning from Mexico he again engaged with the Bullock company. His progress has been rapid, and although a very young man, he has had a wide experience in many lines of electrical engineering.

MR. CHARLES E. WARNER, formerly general superintendent of the Allegheny County Light Company, has been appointed general manager of the San Juan Light and Transit Company, which operates an extensive electric lighting and traction system in the capital of Porto Rico.

W. E. CRANE has assumed charge of the mechanical equipment of the Hotel Astor, Forty-fourth street and Broadway. The steam plant includes four 400-horse-power Rice & Sargent engines, electrical, refrigerating and pumping machinery. The engineering force consists of thirty-two men.

M. V. THOMAS, who three years ago retired from active work, has found idleness hard, and is in harness again as editor of the *Publisher and Retailer*, devoted to book making and handling. Judged by the opening number, the *Publisher and Retailer* will be a welcome addition among the trade journals.

THORNWELL FAY, until recently general superintendent of the Morgan and Louisiana Western lines, has been appointed vice-president of the Texas line of the Southern Pacific Railroad, with headquarters at Houston, Tex. Mr. Fay entered the railroad business at the age of fourteen as a telegraph operator.

WILLIAM MAVER, JR., member of the American Institute of Electrical Engineers, author of "Wireless Telegraphy, Theory and Practice," has published in the American monthly *Review of Reviews* for August an article entitled "Wireless Telegraphy of To-day," in which an excellent résumé of the wireless situation is given.

L. E. BENNETT, who superintended the work of equipping Bangkok, the capital of Siam, with an American electric lighting system and also installed an American plant in the palace of the King of Siam, has been appointed superintendent of construction of the harbor improvements at Cebu and Iloilo, Philippine Islands.

MR. MILO G. KELLOGG has published a voluminous statement regarding the Kellogg-Bell litigation. This statement, which takes up some one hundred pages, contains an introductory statement by Mr. Milo G. Kellogg, a copy of M. G. Kellogg's amended cross-bill, copy of the affidavit of M. G. Kellogg, and a copy of the affidavit of Mr. Robert S. Taylor.

MR. W. H. WHITESIDE, general manager of sales for the Allis-Chalmers Company, was appointed, at a meeting of the board of directors of the Bullock Electric Manufacturing Company on July 30, general manager of sales of the Bullock company. Mr. Whiteside will now have entire charge of the sales departments of both the Allis-Chalmers and Bullock organizations.

MR. CHARLES E. WARNER has accepted the position of general manager of the San Juan Light and Transit Company, San Juan, Porto Rico. Mr. Warner was a student at Cornell University and spent several years in various branches of railway and lighting construction. He was manager of the northwestern agency of the Westinghouse Electric and Manufacturing Company at Tacoma, Wash., from 1893 to 1898. In 1898 he resigned his position with the Westinghouse company, and has been several years in engineering in Alaska, Nova Scotia and New England. Probably his most notable work was done as general superintendent of the Allegheny County Light Company, Pittsburg, Pa.

ELECTRICAL SECURITIES.

The fluctuations in the stock market last week were narrow and irregular, the conditions generally reverting to the waiting attitude which characterized the market several months ago. The cereal crop continues to be a most important factor in shaping events, and it is the imminence of positive reports as to the progress of the harvest that is responsible for the delay in market movements. Notwithstanding continued reports of damage to the crops of this country, the fact of the very great shortage of the Russian wheat crop, and the stringency in other foreign quarters, points to a good demand at prices which will very much increase the ready money of the farmer after his wheat and corn shall have been disposed of. This increase in values, it is claimed, will stimulate an investment demand, both in pure speculation and for industrial enlargements.

Reports from several railroad corporations show that, in spite of decreased earnings, expenses have been lessened to a still greater degree, making a final net increase in profits.

The labor situation does not seem to be much relieved, as the troubles in the meat-packing industry drag along in just about the same condition as a week ago. In New York city there has been inaugurated what may prove to be an extensive labor difficulty between the employing builders and the building trades allied unions. The cotton workers in the Fall River district are still engaging in a disastrous struggle to both sides, and the only satisfactory development in the whole situation is the apparent peaceful end of the contention of the miners in the Allegheny district.

ELECTRICAL SECURITIES FOR THE WEEK ENDING AUGUST 6.

New York:	*Closing.*
Brooklyn Rapid Transit	51⅝
Consolidated Gas	195½
General Electric	162
Kings County Electric	200
Manhattan Elevated	150
Metropolitan Street Railway	118⅞
New York & New Jersey Telephone	148
Westinghouse Manufacturing Company	165

The Westinghouse Electric and Manufacturing Company has issued a circular to stockholders, offering 50,000 shares of new stock on the same terms as the 90,000 shares issued last May, at $80 per $50 share, or 160 per cent. Of this issue, 37,500 shares are stated to have been underwritten at the subscription price. The purpose of the issue is to provide in part for the company's investment in the Lackawanna & Wyoming Valley Rapid Transit Company, the British Westinghouse Company, the Canadian Westinghouse Company, and electropneumatic patents for train control.

Boston:	*Closing.*
American Telephone and Telegraph	137½
Edison Electric Illuminating	251
Massachusetts Electric	69
New England Telephone	123½
Western Telephone and Telegraph preferred	91½

Philadelphia:	*Closing.*
Electric Company of America	8 15/16
Electric Storage Battery common	60
Electric Storage Battery preferred	60
Philadelphia Electric	6¼
Union Traction	53⅞
United Gas Improvement	85½

Chicago:	*Closing.*
Chicago Telephone	120
Chicago Edison Light	143
Metropolitan Elevated preferred	52½
National Carbon common	31
National Carbon preferred	104
Union Traction common	4
Union Traction preferred	26

Northwestern Elevated's July daily average of passengers was 60,816, an increase of 1,423.

Lake Street Elevated's average daily traffic for July was 38,668 passengers, including transfers, a decrease of 517. The report of the company for the year ended December 31, 1903, shows a deficit of $82,065, as compared with a deficit of $26,912 for 1902, and a surplus of $6,204 for 1902.

The daily average of South Side Elevated for July was 69,899 passengers, a decrease of 6,377, on account of the closing of the Washington Park race track.

Receiver John C. Fetzer has issued the full annual report of the Chicago Union Traction Company for the year ending June 30, 1904. The income account compares as follows: gross, $8,590,467; expenses, $6,109,216, leaving net of $2,841,251; other income, $137,019, making the total $2,618,270; charges, $2,352,881, leaving a surplus of $265,389, as compared with a deficit of $364,195 for 1903.

The Chicago Telephone Company installed 918 new instruments during July, and now has a total of 111,630.

ELECTRIC RAILWAYS.

MEYERSDALE, PA.—It is proposed to extend the Meyersdale-Salisbury trolley line to Garrett, Pa.

GOSHEN, N. Y.—The contract for the proposed improvement to the Chester & Goshen road has been let to Winfield Hays, of New Rochelle, for about $20,000.

DANSVILLE, N. Y.—The business men of Mt. Morris are organizing a stock company to construct and operate a trolley line between that village and Craig Colony.

TORONTO, CANADA—Plans have been approved by the railway department for the construction of the Toronto & Hamilton Railway from Toronto westward to the township of Nelson, in the county of Halton.

ST. PAUL, MINN.—The board of county commissioners has granted to the St. Paul City Railway Company a franchise for the extension to White Bear Lake. It is understood that the company will do the work this summer.

OTTAWA, ILL.—The contract for the construction of the electric railway between Pontiac and Dwight has been let by the Bloomington, Pontiac & Joliet Interurban Company. The power-house of the company will be in Pontiac.

RICHMOND, IND.—C. N. Wilson, general manager of the Columbus, Greensburg & Richmond Traction Company, has announced the letting of the construction contract to the Westinghouse company at an approximate cost of $2,000,000.

ALTON, ILL.—Grading for the new electric line between Alton and St. Louis is practically completed from Granite City to Glassboro, a few miles south of Alton, and men are at work building the piers for the bridge over Wood river.

OIL CITY, PA.—Representatives of the Titusville Traction Company are securing rights of way along Oil creek, from there to Rouseville, fifteen miles, which will ultimately, it is thought, be connected up to Cambridge Springs and then to Erie.

SAN JOSE, CAL.—An electric railway from this city to Mount Hamilton is being projected, and a company of local capitalists is being organized to do the preliminary work and float a bond issue. The matter has been taken up by the chamber of commerce.

PHILADELPHIA, PA.—Work is soon to be started on the trolley line that will connect Brownsville and Uniontown, Pa. Philadelphia capitalists are behind the proposition, which includes the merging of several lines operating south of Uniontown.

MILWAUKEE, WIS.—The Fond du Lac & Northeastern Electric Railway has voted to issue $1,750,000 in bonds to build its proposed road, which will be sixty-one miles in length. It is stated that eastern capitalists will furnish the necessary capital.

POTTSTOWN, PA.—Papers have been filed in the recorder's office at Norristown for the building by the Schuylkill Valley Traction Company of a branch line through Limerick and Pottsgrove townships, to be known as the Trappe & Limerick Street Railway Company.

ADRIAN, MICH.—Another electric road is being promoted out of Toledo to connect at Saline with the road running into Detroit. New York parties are said to be back of the plan. The line will pass through Whiteford Center, Bailey's Corners, Riga, Deerfield, Britton and Saline.

JEFFERSONVILLE, IND.—The lines of the Jeffersonville City Street Railway Company will immediately be extended to Utica, Charlestown and other points. It is claimed that the right of way has been secured and that there is nothing in the way of the proposed extension.

NASHVILLE, TENN.—The survey has begun for the Nashville & Columbia Electric Railway. It is the purpose of the company to complete the road between here and Franklin and begin a rapid transit service between these points before commencing the construction of any other part of the proposed line.

BRUNSWICK, GA.—Plans are under way for the construction of an electric railroad from Baxley, in Appling County, to Reidsville, in Tattnall County, crossing the Altamala river near Piney Bluff and connecting there with river steamers between points on the Altamala and Ocmulgee rivers to this port. The scheme is backed by several New York and eastern capitalists, together with a number of Georgia financiers.

WILMINGTON, DEL.—The right of way for the line of the Delaware Suburban Railway Company, from Wilmington to Elkton, Md., has been secured and work started. Eventually it is the intention of the company to extend the road to Oxford, Pa. The power-house will be located at Newark.

PHILADELPHIA, PA.—The Easton Consolidated Electric Company is reported to be securing a right of way for the extension of its lines from Phillipsburg, N. J., to Washington and other points in that state. The proposed extension will give the company a through line from Washington, N. J., to Bethlehem, Pa.

SACRAMENTO, CAL.—The Downieville, Marysville & Susanville Electric Railroad will erect two electric power plants on the Yuba river, one near the mouth of Slate creek and the other at Bullard's Bar. The corps of engineers engaged in making the preliminary survey are now operating in Plumas and Sierra counties.

WABASH, IND.—The Fort Wayne & Wabash Valley traction line will be extended from Logansport to La Fayette next year. It is understood that while the company owns the old Wabash & Erie canal towpath, it will not use that as a right of way, but follow the highway, on private ground, and closely parallel the Wabash railroad track.

BOSTON, MASS.—The Consolidated Construction Company, of Groton, Ct., has filed a certificate of incorporation. It has a capital stock of $100,000, and the incorporators are Augustus F. Phelps, of New York; John A. Morgan, of Groton, and William F. Ellis, of Stamford. The company is organized for the purpose of building and equipping street railway lines.

BOLIVAR, N. Y.—Officials of the Olean street railway are considering the matter of extending the company's line from Bolivar, the present terminus, to Allentown, a distance of six and one-half miles, the right of way between the two places having already been promised the company. It is estimated that it will cost $10,000 a mile to build the proposed extension.

NEW CASTLE, IND.—Surveyors are at work taking the levels over the right of way for the Indianapolis, New Castle & Winchester electric line. The work will require several weeks. It is understood that a survey is also being made over the right of way of the New Castle & Richmond line for eastern capitalists, and that the financing arrangements have been made.

FLORENCE, COL.—Stockholders of the Florence Electric Street Car Company at their annual meeting elected officers as follows: Thomas Robinson, president; H. A. Cook, vice-president and treasurer; Harry Robinson, secretary. This company is organized for the purpose of building an electric car line between Florence and Canon City and the outlying coal camps.

SYRACUSE, N. Y.—The Andrews-New York Central syndicate, which recently purchased the Utica & Mohawk Valley and the Syracuse Rapid Transit trolley lines, has reorganized the latter company, electing Horace E. Andrews, of Cleveland, Ohio, president, and E. V. Rossiter and John Carstensen first and fourth vice-presidents respectively, of the New York Central & Hudson River Railroad Company, directors.

NEW BRITAIN, CT.—The common council has adopted a resolution creating a committee to formulate a suitable bill for introduction to the next general assembly requiring the New York, New Haven & Hartford Railroad Company to provide adequate safeguards for its third-rail system, and thus reduce the risk to which the public is exposed. The committee will submit the proposed legislation to the council for approval or modification.

CINCINNATI, OHIO—J. P. Hornaday & Company, Cincinnati, Ohio, have, as fiscal agents, undertaken to underwrite one-half the securities of the Shreveport & Northeastern Railway, extending from Shreveport, La., through Minden, connecting with the Louisiana Northwestern Railway and several other railway systems in western Louisiana. Construction work will proceed as soon as preliminary arrangements are completed. The road, as now laid out, will be

forty-two miles in length, and will have first-class equipment and terminal facilities at Shreveport. It will traverse a rich territory and is expected to handle a large amount of freight.

LOUISVILLE, KY.—The franchise of the Louisville & Mt. Washington Electric Railway Company, which proposed to project a trolley line on the Bardstown pike from Louisville, through Mt. Washington and Fairfield, has been revoked by the Fiscal Court on the ground that the company had failed to begin construction within the time limit fixed. The company secured a franchise under an agreement to begin construction by April 12, 1904.

TOLEDO, OHIO—Preparatory work is being done at Toledo on the proposed Toledo, Ann Arbor & Detroit Electric Railroad, and in a short time construction will be begun on an extensive scale. Officials of the company say that the road will be in operation within a year from date, and that the company will have direct Detroit and Whitmore Lake connections. A project is said to be on foot to consolidate the line with the Toledo & Indiana electric road.

HARRISBURG, PA.—The Pottstown & Brady Street Railway Company has filed papers at the state department announcing an extension of its line from Douglassville to Manatawney creek, and from Douglassville to Pottstown, all in Montgomery County. The Philadelphia & Darby Creek Street Railway Company, of which W. M. Oglesby, of Harrisburg, is president, has extended its line from Upper Darby township, Delaware County, on the state road, to Media.

EVANSVILLE, IND.—The name of the Evansville & Princeton Traction Company has been changed to the Evansville, Princeton & Indianapolis Traction Company. The company has been reorganized with the same officers. It will extend a branch line from Fort Branch to Owensville and New Harmony and a branch line from Patoka to Union and Petersburg, in Pike County. Later the line will be extended on to Hazelton and Vincennes and connect with Indianapolis.

MILWAUKEE, WIS.—C. T. Reynolds, who is projecting a belt line around Milwaukee, claims, from estimates he has made, the work could be completed for $2,000,000. A part of the route would lie along the lake shore, from Wisconsin street south to the city limits, requiring the filling in of a strip 1,000 feet wide. This would cost $970,000, and would have to be done by the city, as the rules of the government would prevent any private corporation from conducting such an enterprise.

SALT LAKE CITY, UTAH—A franchise for constructing and operating a railroad on the streets of Provo has been granted to B. Mahler, of Ohio, Reed Smoot, Jesse Knight, C. E. Loose, George Havercamp and S. R. Thurman by the council. Under the terms of the franchise the company has eighteen months in which to select the streets which it desires to use. The preliminary survey must begin within twelve months, and at least one track must be completed through the city in three years.

LINCOLN, NEB.—The Loup Valley Electric Railroad Company, which is to build a line from Broken Bow to Gandy, has filed articles of incorporation in the office of the secretary of state. The company has an authorized capital stock of $1,000,000. The object is to build a line of road from Broken Bow west to Arnold, thence west to Garfield, in Lincoln County, and thence north to Gandy, in Logan County. The company's principal place of business is to be the town of Arnold, Custer County. The incorporators are Jacob Miller, B. E. Robinson, C. T. Halliday, Adam Sensel, A. J. Morgan, G. J. Hammond, C. C. Babcock, John Finch, R. E. Allen, W. C. Bettz, Ira P. Mills, Charles Hardin and D. B. Simms.

HAGERSTOWN, MD.—The several electric railways owned and operated in Washington and Frederick counties will shortly be consolidated into one company, and the new corporation will rebond the whole concern. The railways are now practically owned by Christian W. Lynch and William Jennings, of Harrisburg, Pa., who are president and treasurer of the respective companies. The Hagerstown Railway Company operates the system in Hagerstown and the line to Williamsport. The Hagerstown & Boonsboro Company operates the line from Hagerstown to Boonsboro. The Middletown & Myersville Company operates the line between those points in Frederick County. The new company, incorporated to construct a line from Boonsboro to Myersville, contains the same personnel.

TELEPHONE AND TELEGRAPH.

CEDAR FALLS, IOWA—It has been voted to install a telephone system.

SLOAN, IOWA—The People's Telephone Company has been incorporated with $15,000 capital.

DEFIANCE, IOWA—The Defiance Telephone and Electric Light Company has been incorporated with $15,000 capital.

POWERS, MINN.—It is expected that a telephone exchange will be established at Spalding and Powers, Menominee County, within the next sixty days.

OTTUMWA, IOWA—The Iowa Telephone Company will make improvements to its system to cost $80,000. These will include a new central building and conduit work.

NASHVILLE, TENN.—A new private telephone system is being installed in the custom-house. Up to this time the building has had no exchange, a few of the offices having been equipped with separate telephones.

NEWARK, N. J.—The West Orange town council has granted a fifty-year franchise to the New York & New Jersey Telephone Company, the rates charged to be the same as those exacted in Orange and East Orange.

ALTON, ILL.—The Upper Alton village board has granted a franchise to a new telephone and telegraph company composed of farmers who are building a farmers' telephone line from Fosterburg, and desire to connect with the Kinloch and Bell companies in Upper Alton and Alton.

SAGINAW, MICH.—The Bell Telephone Company is making many improvements in its system. Workmen are now engaged in laying underground the telephone wires about the city. In places where they can not be placed below the surface, new poles of better quality and greater length are being set up, and all the wires along these lines will be made into a single cable. In each cable there will be 400 pairs, or 800 wires.

SOUTH McALESTER, I. T.—The Postal Telegraph-Cable Company has ordered several car loads of material to be shipped to this place, and will commence the immediate construction of a line from South McAlester to Denison, along the line of the Katy, and from here to Oklahoma City, along the line of the Choctaw. Later the Postal will extend north from this place to Kansas City, and east from here to Fort Smith, Ark.

HUMBOLDT, NEB.—The deal between the City Mutual Telephone Company and the Humboldt Telephone Company has been completed, whereby for a consideration of $6,000 the latter turns over to the first named concern the franchise, stock and lines of the local exchange. Possession is to be given the first of February, and it is understood close relations have been established between the new company and the rural lines surrounding the city, the entire system to be operated under one management, on the mutual plan. A material reduction in rates is promised.

PEORIA, ILL.—Plans for the new building to be occupied by the Interstate Telephone Company will be rushed to completion as rapidly as possible. The new structure is to be one of the best equipped buildings of its kind in the state. It will be a three-story building, of brick and stone, and will be twenty-six feet wide by 180 feet long. When completed the building will be as near fireproof as it can be made. On the second floor will be a suite of office rooms and a storeroom twenty-six by eighty feet. The remaining floors of the building will be occupied by the telephone company. The switchboard will be 160 feet in length.

SYRACUSE, N. Y.—The Central New York Telephone and Telegraph Company is making temporary improvements to its system in this city which will cost in the neighborhood of $20,000. The switchboard has for some time been crowded to its utmost capacity, and provision is now being made for 1,000 additional telephones. The work is now well under way. The number of subscribers has now passed the 4,000 mark. Plans have been drawn for the new building and the work will be pushed to completion as rapidly as possible, but it will probably be a year and a half before the new switchboard is installed. There will then be provision for 20,000 telephones. The improvements which are contemplated will cost nearly $1,000,000.

INDUSTRIAL ITEMS.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., publishes, for the month of August, a very attractive little desk calendar.

THE BAYLIS COMPANY, New York, has issued bulletins Nos. 507 and 421, descriptive of the "Reaction" brush-holder, and No. 412, general data and dimensions.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio, in bulletin No. 221 shows cuts and descriptions of its direct-connected generators in the marine and engine types.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., reports that an unusually large number of central stations are contracting for its Packard lamps, and that it is preparing to handle the fall demand.

THE H. W. JOHNS-MANVILLE COMPANY, New York, under the title "Two Sides of a Story" issues a folder descriptive of "Mobilene," a sheet packing for gas and gasoline engines, for stationary, marine or motor vehicle service.

WILLIAM DEMUTH & COMPANY, 507 Broadway, New York city, have secured a large quantity of low grade meerschaum which, while not good enough for smokers' use, is a good non-conductor of electricity. They are of the opinion that it can be used for insulating purposes.

THE JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, in its catalogue No. 67A, which represents some of the printer's best skill, shows its specialties in rubber belt conveyers and conveyer supplies. Electric power is used almost entirely for the operation of these conveyers.

J. S. BARRON & COMPANY, New York city, are calling attention to a large line of telephone cleats which they carry in stock. These cleats are made in every size and style for telephone and telegraph service. The company also manufactures a strong line of fibre cleats for interior wiring of every description.

THE NERNST LAMP COMPANY, through its Denver office, is introducing and popularizing the Nernst lamp in all kinds of business. Mr. R. D. Marthens, the manager, has received contracts for lighting the United States Army post at Fort Logan, Col., and a number of large business houses at Cripple Creek.

THE SUNBEAM INCANDESCENT LAMP COMPANY, through its sales agent, the Western Electric Company, Chicago and New York, is calling the attention of the trade to the new "Baby" bunghole lamp. This lamp is made in all voltages from 90 to 130, two and four candle-power, and is especially adapted to decorative work.

HENRY R. WORTHINGTON describes in bulletin No. 100, the Worthington steam hydraulic accumulator. This device consists of an ordinary steam cylinder combined with a ram cylinder, similar to that of a weighted hydraulic accumulator, and is applicable to all works requiring the storage of water under high pressure.

THE NEW YORK TELEPHONE COMPANY, 15 Dey street, New York city, has prepared a handy reference calendar containing on each leaf of the pad the calendar for three months. This serves the purpose of giving at a glance the last and coming months, as well as the present month. Mr. W. F. Baker is the contract agent for the company.

THE EDISON ELECTRIC ILLUMINATING COMPANY, Boston, has issued the "Edison Light" for August. It gives a slight idea of the multitudinous uses to which electric power is being put. A cut of the bronze bust of Thomas A. Edison, presented to Charles L. Edgar by his employés and others, is shown. Judging from the picture, it is an excellent likeness.

THE KNICKERBOCKER CONSTRUCTION COMPANY, New York, has received a contract for the installation of the underground and aerial cables for the new Lewiston-Auburn, Me., Automatic Telephone Company. The cable, which will be over 100,000 feet, is being manufactured by the Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y.

THE E. W. BLISS COMPANY, Brooklyn, N. Y., has issued catalogues descriptive of its straight sided power presses, punching presses and Sprue cutters; also a catalogue of its machinery, published in Spanish. A memorandum booklet will be welcomed by all engineers, as it contains facts and data in a very handy form. Any of this literature will be mailed upon request.

THE AMERICAN ELECTRIC FUSE COMPANY, Chicago, has on exhibition at its Chicago office, 50 West Jackson Boulevard, one of the latest types of the Allen-Bradley electric crane controllers, and will be pleased to exhibit it to interested parties. This crane has recently been submitted to a number of satisfactory tests by some of the largest manufacturing companies in the United States.

THE LANE & BODLEY COMPANY, Cincinnati, Ohio, are mailing cards showing cuts of the crank side of their Twentieth Century twenty-two by forty-two heavy duty Corliss engine; a pair of their twenty-four by forty-two link motion, heavy duty winding engines and a view of the direct-connected Twentieth Century heavy duty Corliss engine operating the intramural railroad at the St. Louis Exposition.

THE PHILADELPHIA AIR BRAKE COMPANY, Real Estate Trust Building, Philadelphia, Pa., has issued a catalogue descriptive of its air brake apparatus. This catalogue is presented especially to street railway managers. The particular improvements which the company places on the market are the duplex jam cylinder and the automatic cutoff. Descriptions and illustrations of these are given in the catalogue.

THE SARCO COMPANY, 906 Sixth avenue, New York city, manufacturer of the "Sarco" specialties, is busy filling orders for its aluminum parabolic reflectors. These reflectors clamp onto the lamp, and can be manipulated with great facility. A popular specialty which the company is placing on the market is the "Sarco" key arm switch. This allows all fittings and wiring to be made without injury to the moulding or plastering, and permits the use of a keyless lamp socket.

DODGE & DAY, engineers, Philadelphia, who will enlarge the plant of the Victor Talking Machine Company, have completed their plans and specifications. They contemplate the use of 600-horse-power horizontal tubular boilers in four units, each eighteen feet long and seventy-two inches in diameter, with a working pressure of 125 pounds; two horizontal automatic high-speed engines, 160 and 240 horse-power, direct-connected to 100 and 150-kilowatt generators, and fifteen electric motors, ranging from five to seventy-five horse-power.

THE WELLMAN-SEAVER-MORGAN COMPANY, Cleveland, Ohio, engineers and manufacturers, have recently issued a finely printed bulletin illustrative and descriptive of the engineering applications in which they are interested. This organization is a stock company incorporated under the laws of the state of Ohio for the purpose of transacting a general engineering and manufacturing business. The booklet gives a general classification of the engineering work which the company undertakes, and also a classification of the manufacturing work.

THE SPRAGUE ELECTRIC COMPANY, New York city, has for many years been identified with the manufacture and installation of electric motors for operating ventilating fans and blowers. Among recent installations of these motors, which are particularly adapted to this class of service, are the ventilating apparatus in the Chicago post office and the New York city and Brooklyn public baths. In the West Forty-first street and East Seventy-sixth street public baths there will also be installed two thirty-kilowatt and two twenty-five-kilowatt Sprague engine-type generators.

THE NATIONAL ELECTRIC COMPANY, Milwaukee, Wis., successor to the Christensen Engineering Company, manufacturer of Christensen air brakes and electrical machinery, has completed extensions to its foundries, and is now soliciting orders for open hearth crucible steel, semi-steel, iron and brass castings. The foundries are equipped with every facility for rapid and economic output, and as the nature of the company's own work demands castings of the highest grade, the material furnished on orders will be of the same quality, and will receive immediate attention.